THURSDAY, OCTOBER 25, 1883

A SCIENTIFIC CATALOGUE

Bibliotheca Historico-Naturalis et Mathematica. Lager-Catalog von R. Friedlander und Sohn. (Berlin, 1883.)

LIKE enthusiastic physicians who are charmed with a "splendid case"—of Asiatic cholera, it may be—which illustrates or disproves some theory which has engaged their attention, there are philologists who are so interested in tracing the growth of variations among dialects by watching for and marking fresh changes in a parent language under different circumstances that they do not consider what an inconvenience this polyglot condition of society is, and what a length of time and amount of labour all but a gifted few have to expend in order to learn even three or four of the principal languages of ancient and modern times. Some considerations lead us to hope that, following many other benefits that scientific study has unweeningly brought to man, a unification of languages also may be in store.

As science spreads and makes way, the more indispensable to inquirers in each country becomes the knowledge supplied by the phenomena or the intellect in all others. Knowledge cannot be largely produced by a kind of secret manufacture of which one country or one race only knows the process. It must be *patent* in the older sense! Inductive science requires such a variety of observation of positive fact, and is so largely helped by comparison of working theories, that hardly any subject can be thoroughly studied without consulting both the facts noted by observers and the hypotheses started by philosophers in other countries. Commerce has, no doubt, brought a large number of men from many parts of the world into oral communication, but they are not of the class who have the means or the ambition to guide a language, as a majority of scientific writers are,—men who must largely control the education of their country.

But we have not arrived anywhere near the harbour of a common language yet. The first step has no doubt been taken by the agreement to use Greek roots for all scientific terms, so many of which keep forcing their way into familiar language through the utilitarian purposes connected with them; and science may claim its share also in the recent and increasing disuse of the old black-letter type by the Germans, and the adoption of the more general Arabic character—as in this publication, to which we are much pleased to call attention as a step towards counteracting the inconvenience now laboured under through the results of the tendency of languages to diverge. We have in England a fair sprinkling of libraries in which tolerably complete collections of English works are to be found, and the narrow boundaries of our crowded population make the use of them pretty practicable to the working student. But only a very few indeed of these contain at all complete collections of foreign publications; and, without doubt, the cosmopolitan studies of the Germans, their numerous universities—each, as Prof. Ray Lankester reminded the British Association, with a Government endowment sufficient at least to allow an earnest worker to follow up any pursuit which has raised his enthusiasm, and each as a matter of course engaged to some extent in original research—make their country the home and the market for such a collection of books as this. The special characteristic of this list is that it is restricted to science. The publisher was a successful student at the University of Berlin, where natural science was his favourite branch An American friend persuaded him to continue his studies at one of the United States Universities. He made many friends there, but his father's death brought him back to Europe, and the large family of them which were left required him to give close attention to business. His knowledge, however, of science, and his connections in the United States, enabled him to get, and to execute with more than usual success, large orders for the different great libraries as they were successively founded there. He made it the work of his life to form as complete a collection as possible of all scientific books and publications, and the results are shown in this book, printed with a care which foreign writers would seldom find bestowed upon their names and upon the titles of their books in an English printed catalogue, and, although containing about 1250 pp., deserving to be classed as a handy volume. Nearly 50,000 entries of publications on science only are made, with the most full particulars as to illustrations, size, date, &c. These are divided into 169 catalogues of works upon as many different subjects, upon which very elaborate classification we must remark that while no doubt suiting any consulters who only wanted a choice of books upon a subject, the dividing and classifying must add immensely to the labour expended upon it, and nevertheless reduce the value of the catalogue to the very students for whose benefit we are told that the compilation was made, viz. workers who wanted to know what upon each subject had been written in all scientific countries. For, as any one who glances down the index of subjects would see, there are very many books which are equally appropriate to half a dozen of them; and, since the same work is not repeated in list after list, it is necessary to consult an unknown number of them before the catalogue has answered the purpose intended. Of course it is difficult also to bring so general a list down to any date close upon that of publication, important as that is to all scientific writers especially, and the omissions which may be traced in this great collection are a striking evidence of the wealth of modern scientific literature.

THE FISHERIES OF THE ADRIATIC

The Fisheries of the Adriatic and the Fish thereof. A Report of the Austro-Hungarian Sea-Fisheries; with a Detailed Description of the Marine Fauna of the Adriatic Gulf. By G. L. Faber, Her Britannic Majesty's Consul, Fiume. (London: Bernard Quaritch, 1883.)

NO comprehensive work has till now appeared in English on the sea-fisheries of the Austro-Hungarian Empire, and though Mr. Faber modestly refers to his volume as a Report meant to pave the way for a more general work on the subject, yet we cannot but regard it as a very valuable history of the marine fauna and fishing interests of the Adriatic. The volume contains a systematic list of the fishes, including the freshwater forms of the watershed of the northern and eastern shores of the

Adriatic, which has evidently been compiled with a great deal of care. The Italian local names in use on the Adriatic coasts and the Croatian names are also given; those of the latter dialect for the first time.

The author commences with a short description of the Adriatic Gulf. Its tides are inconsiderable, the normal rise and fall being only 1½ foot, and only one ebb and flow in twenty-four hours. The currents, however, are numerous, acting as modifiers of the effects of climate and influencing by their agency the diffusion of marine life. The nature of the sea bottom varies immensely, giving abundant choice to the various species of fish. The sea water proper is, in respect of the degree of saltness, about the same as the Atlantic under the tropics, but springs abound in some regions to such an extent as to render the surface water thereof quite fresh. With a for the most part moderate depth, yet 100 fathoms is reached near the islands of Zuri and Scoglio Pomo, and near the island of Meleda the bed has not been reached at 500 fathoms.

In the second chapter we find a history of the present state of the fisheries. The demand now exceeds the supply. The decrease is ascribed to the effects of trawling, though without the slightest reason. One great drawback to the preserving of fish seems to be the State monopoly of salt. Full details as to the fishing of Italian boats in Austrian waters are also given. In the third chapter the various fishing districts and their peculiar products are detailed; besides fish, sponges are obtained in the vicinity of Crapano and coral near Zlarin. Pola is the best district in Istria for the tunny; it is now a town of 20,000 inhabitants, in 1856 it was a village of but 600 inhabitants. In value the sardine fishery holds the first rank, being computed at about 40,000*l.* a year, while the tunny fishery yields about 15,000*l.*, and the red mullet take is calculated at 12,000*l.* The average annual value of squid (*Loligo sepiola*) captured is 12,000*l.* The various sorts of craft used in fishing are described and figured in Chapter IV., with calculations of their value, number of crew, &c. Nets, basket traps, fish weirs and ponds are treated of in Chapter V. The tanning process is effected by a solution of the bark of *Pinus maritimus* in sea water, but for very fine nets the leaves of the pistachio, shumac, myrtle, and heath (*Erica vulgaris*) are used. Chapter VI. describes the hooks and lines used. Chapter VII. treats of the names applied to fishermen and various modes of fishing. The fish markets of the Istrio-Dalmatian coast are described in Chapter VIII. The well-defined sorts which appear in these markets may be given at ninety fishes, often uniting under one name various species of the same genus, thirty mollusks, and ten crustacea, but in addition there will be found sea urchins (Echini), an actinia (*A. cereus*), and such an ugly form as *Ascidia microcosmus.* The methods of curing and cooking fish are detailed in Chapter IX. The curing of pilchards in oil after the fashion of sardines seems to have met with a well-earned success, but the tins have to be imported from England and the oil from Italy or France. Chapter X. is devoted to statistics; those of the Austrian sea-fisheries are compiled with commendable exactitude and completeness, and are regularly published in the *Austria*, the statistical periodical of the Austrian Ministry of Commerce. We wish that we could say the same for our British sea-fisheries. The very valuable appendix contains a catalogue of the Adriatic marine fauna, and the local names given to the best known forms. The typography and illustrations of this handsome volume leave nothing to be desired even in these days of luxurious editions. We agree with Dr. Günther in believing that to the great number of persons who annually leave our shores for the Mediterranean in quest of sport and recreation this work will serve as a guide to a field of pleasant research, hitherto much neglected. It is also a most important contribution to the knowledge of the economic resources of the sea-coast and rivers of a deeply interesting country, and we hope that one of the results of its publication may be to greatly develop a practical interest in the fish treasures of the Adriatic Gulf.

OUR BOOK SHELF

Practical Electrical Units Popularly Explained. By James Swinburne (late of J. W. Swan and Co., Paris; late of Brush-Swan Electric Light Company, U.S.A.). (London and New York: E. and F. N. Spon, 1883.)

THE title of this book will doubtless lead those to whom "ohms," "amperes," "farads," &c., seem so mysterious to hope that all difficulty in understanding what they are and whence they come will be removed. They will find, however, that though the relations between the practical units are given very clearly, and are illustrated by many numerical examples, yet the definitions are "definitions in a circle." Mr. Swinburne has neither shown how the C.G.S. units are derived, nor has he even given the relations of the practical to the C.G.S. units.

The mechanical units are fully described on the English system, which perhaps is better suited for purposes of explanation than the French, as being more familiar to most people. In speaking of the term "electric fluid," Mr. Swinburne uses this rather dangerous language: "Electricity can be looked upon as an imponderable fluid which, like a gas, is compressible, the volume varying inversely as the pressure, so that if the pressure be doubled the volume is halved." It does not appear at once to what this refers, but six pages on the meaning is explained, for we read: "It may seem strange at first that there should be a unit of quantity, and another of capacity to hold that quantity, when we do not need to call a pint measure by one name and the quantity of liquid it holds by another. It must be remembered that electricity corresponds to a compressible fluid; and though the pint measure holds, or is supposed to hold, a pint of liquid, the amount of gas it would contain would depend on the pressure." This is one of the many excellent concrete analogies by which Mr. Swinburne assists his readers to understand those actions which at first seem to many so unintelligible.

It is not clear in what way the following note will assist mechanical engineers or any one else to understand the nature of electromotive force. "Force is generally looked upon as what tends to move matter, and the term 'electromotive force' seems therefore a misnomer at first sight. Science does not know what electricity is, but it is supposed to be a kind of motion of molecules or of ether very closely related to heat and light. Science knows little about molecules or ether, and does not even know if there are such things, but thinks the next thing to understanding anything is naming it."

The book is not meant to be a scientific work, but is intended to help mechanical engineers and others to understand the units with which they may have to deal; for this purpose the simple language and the numerous examples will be sure to make it succeed. C. V. B.

The Fishes of Great Britain and Ireland. Being a Natural History of such as are known to inhabit the Seas and Fresh Waters of the British Isles, with remarks on their Economic Uses, and Various Modes of Capture. By Francis Day, F.L.S., &c. (London: Williams and Norgate, 1880-1883.)

THIS new work on the "Fishes of Great Britain and Ireland" is to consist of nine parts and about 200 plates. Of these the first six parts, bringing the pages to 176, and the plates to 132, have already appeared. Not only is the natural history of the marine and freshwater fishes given with very copious synonymy, but we find in addition the habits of the fish detailed, the means of their capture, the artificial breeding, the use for food, and the best methods of cooking given. The scientific merits of the book are such as we might expect from the author of "The Fishes of India," and from one who occupied the important post of Inspector General of Fisheries in India, while there is further, in the accounts of the habits of the fish and of their means of capture, an amount of most interesting details to the general reader and sportsman. The plates are from drawings by the author, and though uncoloured are very effective. In most cases where desirable the stomach and pyloric appendages, the air bladder or the mouth with the teeth are added to the portrait of the species. When completed the work will form a handsome royal octavo volume.

Parrots in Captivity. By W. T. Greene, M.A., M.D., and with Notes on several of the Species by the Hon. and Rev. F. G. Dutton. Coloured Plates. (London: George Bell and Sons, 1883.)

THREE parts of this well-ilustrated work on parrots kept in captivity have already been published, and considering the extent to which these splendidly coloured and interesting birds are to be found domesticated in our country, this treatise on their habits will no doubt be very acceptable to many of our readers. The directions given as to their food seem based on practical experience, and will be welcome to some who in this respect may have wrongly treated some favourite bird. The author insists pretty strongly on not characterising a species by the behaviour of an individual, fairly arguing that it is just as wrong to declare that all the cockatoos are noisy and spiteful or that all the lories are amiable and well-behaved as it would be to declare that all Englishmen are lively or all Frenchmen sad because persons of these nations had been met with having these characteristics.

Voyages of G. S. Karelin on the Caspian Sea. Memoirs of the Russian Geographical Society; Section of Physical Geography, vol. x. 497 pp. (St. Petersburg, 1883.)

M. KARELIN, who died in 1872, in the province of Orenburg, to which he was exiled in 1824, was well known to naturalists in Russia and Western Europe as an indefatigable collector in mineralogy, botany, and zoology, who supplied Russian and foreign museums with rich collections from Eastern Russia and Siberia. But, with the exception of a few papers in botany and zoology, none of his most valuable works have appeared in print. Most of his manuscripts are lost, and of his remarkable journey to the Altaï and Sayan, where he spent several years making his richest collections, only a few fragments of diaries have been discovered. Prof. Bogdanoff publishes now the two diaries that Karelin kept during his journeys to the eastern coasts of the Caspian Sea, performed in small vessels in 1832 and 1836. During the first of these voyages Karelin visited the north-eastern coast and the Gulf of Mertvyi Kultuk; four years later he visited the Gulfs of Astrabad, Krasnovodsk, Kara-Bugaz, &c., and penetrated also into the country, making an excursion into the Astrabad province, and another to the great Balkhan Mountains, where he entered into communication with the Turkomans. All these tracts have been visited and described since, but still the reading of Karelin's diary, which shows a fine observer of the physical characters of the countries visited, and of the people met with, is a real pleasure; while numerous remarks on the flora and fauna, scattered in the diaries, have lost very little, or nothing, of their interest from the more recent descriptions. Both diaries are followed by most valuable general descriptions of the flora and fauna of the shores of the Caspian; the lists of species met with, altogether exactly determined, have been revised by Prof. Strauch and M. Gobi, thanks to the numerous collections he made during his journeys. His remarks on the old bed of the Amu-daria, which he visited and mapped in 1836 as far as 37° E. long., are fully confirmed by recent researches; whilst his descriptions of the nature and inhabitants of the province of Astrabad and of the Turkoman coast, and his remarks on the falling of level of the Caspian, are still as valuable as if they were written to-day. The work is accompanied with maps of the Gulfs of Astrabad, Hassankuli, and Krasnovodsk, and of the Balkhan Mountains, which enable us to conclude as to the changes in the configuration of the coast line during the last fifty years.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Green Sun

FOR two or three days we have been having a modified repetition of the phenomena respecting which I wrote you at some length by the last mail; while, curiously enough, if there is no connection between them, the telegraph announces fresh eruptions in Java on the 16th inst. This time, however, while there is apparently about the same smoky haze in the sky, it is much thinner, showing very plainly after the sun has set, but invisible while the sun is much above the horizon. There is also very little of the refracting medium to which I referred in my last, as there is only a slight discolouration of the sun before setting, and scarcely anything of the succession of colours afterward as compared with what we had two weeks ago. I send herewith a few clippings from Indian papers in regard to the matter. The curious appearance of two weeks ago, so far as I can learn, was not seen north of Masulipatam on this side, or Calicut on the west coast. W. R. MANLEY

Ongole, India, September 24

The following cutting, sent us by Mr. Manley, is from the *Englishman's Overland Mail* of September 23:—

Some excitement has been caused in Madras lately by the fact that many persons have observed that both the sun and the moon presented a green appearance when near setting. Prof. Michie Smith thus explains the phenomenon in the *Madras Mail*:—The appearance of a green sun is very uncommon so far as I can discover, but fortunately there is one recorded observation which throws much light on the subject. Lockyer once observed the sun to be of a vivid green when seen through the steam of a little paddle boat on Windermere. This at once points to the solution of the difficulty, and shows us that the cause of the appearance is due to water vapour in the atmosphere. That it is entirely due to this I am not prepared to affirm, for some observations of Dr. Schuster point to an influence produced by suspended matter in the air. This, however, I think we may neglect at present, and consider why the vapour which usually gives us the red sunset tints should at present give green colours. To settle this point I have made careful spectroscopic observations, and, though I have not yet reduced them, I find that they indicate a very marked absorption in the red end of the spectrum extending nearly to B, with a great development of the "rain band" near D on the red side accompanied by a decided deficiency of the band on the green side, called by Piazzi Smyth "the low sun band." Hence we have less red than usual and more green. This is due, in part at least, to the sunlight passing through a more than ordinary dense stratum of aqueous vapour, for we know that the thicker the stratum of vapour the more is the red light absorbed. But this is not all, for we have quite as much vapour without this green colour, but in these cases the sun, I believe, is not seen at all, but we get strips of green sky which are often seen. The atmosphere then, I believe, contains at present a large amount of vapour existing actually as vapour, and not condensed into clouds; hence even a great thickness of it is transparent except to those particular rays which aqueous vapour absorbs. The green colour can be seen only at a particular altitude, for only there is the thickness sufficient to produce the necessary absorption. At higher altitudes the peculiar pale silvery white is exactly what we are to expect.

WILL you allow me to submit to the further consideration of the competent whether this phenomenon, seen at approximately the same time in Southern India, Ceylon, and the West Indies, could be due solely to the presence in the atmosphere of the vapour of water. Is not the air in these regions normally surcharged through a considerable period of every year with vapour of water? And yet not only is this an unusual appearance, but it has excited, wherever observed, both wonder and some alarm. In one respect the observation from Ceylon (NATURE, vol. xxviii. p. 597) is the most noticeable we have had yet, inasmuch as, even when the sun had attained "the very zenith," his light is said to have continued blue. My doubt is whether a phenomenon so rare could be due solely to a cause so everywhere common. HENRY CECIL

Bregner, Bournemouth, October 22

P.S.—When Mr. Lockyer saw his green sun through the steam on the boat, were there not also mingling with the vapour sulphurous fumes from the funnel?

[The sun has been seen green through mist on the Simplon. —ED.]

Snake Poison

TOUCHING the effect of *Crotalus* venom on vegetable life, I am anxious to repair an error which appears on p. 552 of my work on "Snakes," where Dr. Mitchell is made to affirm that some healthy vegetables inoculated with the poison were "withered and dead next day, as if scathed by lightning." In some notes which I made many years ago on a too cursory reading of Dr. Mitchell's paper,[1] I omitted the inverted commas, which denote that the experiment was tried by Dr. Gillman of St. Louis, in 1854, but which Dr. Mitchell thought was too limited and wanting in detail to be of scientific value. I had overlooked Dr. Mitchell's comments and his own experiments on vegetable life, by which he was driven to the conclusion that the plants were injured by mechanical wounds, and *not* by the venom inserted into them. When writing my chapter under pressure of time long afterwards, I trusted too confidently to those careless notes, and to an impression gained through the old Virginia writers that venom *is* injurious to vegetable life.

But in a most interesting series of experiments twenty-five years ago Dr. Weir Mitchell found that the venom did *not* interfere, nor did it arrest alcoholic fermentation and its accompanying growth of sporules. To test it on the higher vegetable life he wounded plants in various parts of their stem and in various ways, taking three or four plants of similar size and growth—geraniums, tradescantia, and others—both succulent and of woody fibre, inserting venom into some and not into the others which were identical in character, and carefully noting the effects on each, which, for the most part, were similar in the inoculated and the merely wounded plants, the symptoms being such as were produced from the injury to the tissue, the leaf, or stem, as might be. "In many successive efforts to poison other plants with venom," says Dr. Mitchell in summing up the results, "*I failed in every instance.*"

A more careful perusal of Dr. S. W. Mitchell's paper now enables me to offer this explanation of the misrepresentation of those exceedingly interesting experiments, fully detailed in vol. xii. of the "Smithsonian Contributions."

Cleveland, Ohio CATHERINE C. HOPLEY

[1] "On the Venom of the Rattlesnake," by Dr. S. Weir Mitchell, "Smithsonian Contributions to Knowledge," vol. xii. 1860. Washington, D.C., United States.)

Simultaneous Affections of the Barometer

MY thanks are due to Dr. Balfour Stewart for his kindly pointing out that simultaneous movements of the barometer, like those I had described in my paper of January last, and also in the "Brief Sketch of the Meteorology of the Bombay Presidency in 1881," written in August, 1882, were first observed by the late John Allan Broun. Owing to my connection with meteorological work being short—of only fourteen months' duration—my attention had not before been drawn to this fact. It is to me interesting to learn also that the late John Allan Broun considered that there was a connection between these movements and the earth's magnetism.

The *Proceedings of the Manchester Literary and Philosophical Society* for the last few years do not appear to have been received in Bombay, but they have now been applied for.

A. N. PEARSON

Meteorological Office, Bombay, September 14

Table of Different Velocities

IN reading over the interesting table of velocities drawn up by Mr. James Jackson, and published in NATURE to-day (p. 604), there is one item omitted, which the author may like to add to his list, viz. the rate at which detonation travels, as exemplified by a train of compressed gun-cotton. This has been computed by Abel and Nobel to be between 17,000 and 19,000 feet per second, or rather more than 200 miles in a minute. In Mr. Jackson's table, therefore, the detonation of gun-cotton would come in somewhere between the velocity of sound in water and the velocity of electricity. H. BADEN PRITCHARD

Woolwich, October 18

OSWALD HEER

WE briefly announced last week the death, on September 27, at Lausanne, of Dr. Oswald Heer, Professor of Botany in the University of Zurich, aged seventy-four years and twenty-seven days. He was born at Nieder Uzwyl, Glarus, Switzerland, August 31, 1809. His whole mind seems to have been imbued from an early age with an intense love of nature, and his devotion to it led him to prefer its study to the discipline of the Church, which he had entered. Heer's early reputation was made as an entomologist, and from 1834 forwards he published many works and papers on entomology, chiefly on Swiss insects, and more especially on Coleoptera, most of which treated exhaustively on the vertical distribution of species in the Alps. Possibly he is best known (as an entomologist) in this country by his monographic work on the beetles of Switzerland, which appeared in 1838–41. In this work he did for the Coleoptera of that country what Frey has more recently done for the Lepidoptera, but, of course, lapse of time has rendered Heer's labours out of date as compared with Frey's. This monograph appeared in two forms, but that which is best known was styled "Fauna Coleopterorum Helvetica," and extended to over 600 pages. But his attention was soon attracted, perhaps by some fortunate chance, towards the remains of plants which were being disinterred from the Tertiaries to the north of Lausanne and elsewhere on the Lake of Geneva, and his whole energy became absorbed in unravelling and restoring the vegetation of the past, and continued so until the close of a laborious life. In 1855 appeared the sumptuous "Tertiary Flora of Switzerland," a work which at once placed him in the first rank as a specialist; and being a prolific and imaginative writer, untiring industry, he has since contributed to palæontology a nearly uninterrupted series of works on his favourite subjects, terminating but last year with the sixth volume of the "Flora Fossilis Arctica." Few earnest workers have lived to see their work more highly appreciated, and the gratification he must have felt at the substantial honours that were showered upon him for many years, from grants of money to honorary distinctions of the highest order, must have gone far to compensate for a malady which had for several years left him bed-ridden. The high reputation he so suddenly acquired, more especially in England, was doubtless mainly due to the friendship of Sir Charles Lyell, who constantly quoted his works, almost to the exclusion of those of other writers on similar subjects. His quickness in seizing the characters of even fragments of fossil leaves, his aptitude in describing them combined with the boldness of his inductions and a certain grace of diction, centred attention on his work, and unconsciously diverted it from his eminent contemporaries, Unger, Goeppert, Saporta, and Ettingshausen. The place he occupied was unique, and his opportunities were proportionally great; his loss will be felt, for it will be difficult to find workers, as competent, either able or willing to dispose with such rapidity of the constantly increasing material brought from distant, and especially Arctic, expeditions

The subject which he had thus made his own is one of exceptional difficulty, both from its wide range and the character of the material to be dealt with, and the path which he trod with such assured steps will be trodden by others with doubt and hesitation. If imitation is the sincerest form of flattery, then was Heer most amply flattered, for nearly all works on the newer fossil floras have been modelled on his bases, and he has become the founder of a school which bids fair to monopolise for some time to come this branch of palæontology. It is no disrespect to the dead to mention the open secret that nearly all English botanists, and very many geologists, have doubted the possibility of determining, except in rare instances, the detached and broken leaves which make up nine-tenths of the Tertiary floras. It is fortunate that Heer's temperament was sanguine, and his belief in his power to interpret the material unlimited, else the marvellous Tertiary floras from the Arctic circle, which so profoundly exercise the imagination, would have remained a sealed book. His powers are the more surprising, as his health does not appear to have permitted much travel, a winter spent on the cultivated side of Madeira seeming to have been his only actual acquaintance with extra-European floras. Much of his work, too, was produced under conditions the reverse of favourable for exact determination and comparison: a friend relates that when calling to convey one of the numerous awards made to him by English scientific bodies, he found the Professor lying down with a small table arranged to cross the bed, upon it being specimens which he named while an assistant made drawings.

Besides the fossil floras and insect faunas of his own country, his works comprise, among many others, descriptions of the Carboniferous, Jurassic, Cretaceous, and Tertiary floras from round the Arctic circle, and from Germany, Austria, Italy, Portugal, and even more distant countries. In 1861 he was invited to England to describe the Tertiary flora from Bovey Tracey, and a work appeared upon it in the *Phil. Trans.* of the following year. It is certainly strange that this and nearly the whole of the fossil floras containing dicotyledons examined by him have been referred to the Miocene age, and certain prevailing types seem to recur in the greater part of them; but it is not our province to discuss the correctness of these views here. He was much in earnest and zealous in the extreme, and the importance and value of his work, including as it does figures and descriptions of species which may almost be numbered by the thousand, is incontestable. So much accomplished, in spite of ill health and probably with less extensive herbaria to consult than are available in this country, commands respect; and however the study of fossil plants may rank in the time to come, Heer's name will for ever be bound up with it as its great pioneer.

THE BACKWARD STATE OF CHEMISTRY IN ENGLAND

In the address of the President of the British Association last year the report as to progress in one of the principal Sections, that of Chemistry, is certainly a very meagre one. It is indeed confined to a general statement of the value of materials derived from coal and coal-tars, &c., and cannot, strictly speaking, be termed chemical. Again, in the address of the President of the Chemical Section, the existence of such a branch or division of chemistry as that termed "organic," and in which more perhaps has been done during the past twenty years than in mineral chemistry during the century, is completely ignored. And unfortunately the reason does not seem far to seek, for very few of the papers presented to the section had direct connection with the chemistry of carbon.

But it is not only at the British Association meetings that this neglect of organic chemistry occurs, but even at the Chemical Society itself the number of contributions to this section of chemistry is very small. In 1881, out of more than eighty communications to the Society only about thirty are relating to carbon compounds. In 1882 the proportion is somewhat greater—thirty-one out of sixty-five. It would be perhaps very unfair to institute a comparison between our Chemical Society and a much younger one, that of Berlin, as they are somewhat different in constitution: and the feeding ground, if it may be so called, is more extensive in the one case than in the other, but still the disparity in number of papers is scarcely to be accounted for in this way.

Chemistry generally, and especially the so-called organic chemistry, appears to have been very much neglected for some years past in this country.

The cause of this lagging behind, especially in a science of such infinite practical applications as chemistry, by this country is somewhat difficult to understand.

We certainly have not the number of chemical schools in England as in Germany, but making allowance for that and comparing the past decade in the two countries we appear to be grievously behind, both in number of investigations as well as in their theoretical or practical importance.

The cause can scarcely be attributed to any want of energy or appreciation of the value of research on the part of our manufacturers, for they are in many instances obliged to seek assistance out of the country. It seems to some extent rather to be owing to a non-appreciation of the science by the general public, although in its more elementary stages it is more extensively taught than in any other country, and this non-appreciation reacts injuriously on the schools themselves. Although such an intensely practical science and capable of such varied applications, the chemical investigator must pass over many weary stretches of complex and to all appearance purely theoretical and useless work before reaching a brilliant practical result.

Unfortunately, until quite recently but few of our schools were so constituted and equipped that a student might work on anything like equal terms with his fellow in a German school.

Now, however, we have a goodly number of chemical schools rising up, with in many cases professors trained in German laboratories. But in many of these the professor labours under the great disadvantage, not only to himself and the science, but to the students, that he has too much mere routine teaching and too little time for that original work, or research, which acts so powerfully in encouraging and stimulating his students to get more than a mere insight into the working and mechanism of the science, and become investigators themselves.

The cost of working in an English laboratory is somewhat greater than in a German one, but this difference is no longer great, and does not by any means account for the difference in results between the two countries. The German student as a rule works very much longer, that is, he is a student for a longer time than the English student, who too often commences his study of chemistry not as a mental training but as a means to an end: to become a public analyst or a works analyst, and who desires to learn only as much as is absolutely necessary for some particular line he has chalked out for himself; or, worse still, to "pass" some "examination."

The importance of chemistry, especially that more regular and systematic chemistry of the carbon compounds, as a philosophical training is not yet by any means recognised in this country. And it is to be feared that until this is remedied we shall still remain, in spite of new schools, in a backward position.

According to an authority like Prof. Wundt, even qualitative and quantitative analysis are, as logical methods, superior to mathematical.[1]

There is no reason to suppose that the ordinary English student is inferior to any other, and when this subject is put before him in a proper light, as a mental training of the highest order, and not simply a mechanical sort of process, more cheerful results may be looked for. But the students in our higher schools and universities should not stop at qualitative and quantitative analysis, but if possible do some synthetic work, as by this only is a real grasp of the science to be obtained.

When once we get a substratum of well-trained students, not simply analytical machines, or examination-passers, we shall not have long to wait for results of theoretical and also practical interest.

But our professors must also bestir themselves. In very few institutions in England are more than elementary courses of lectures given, generally the same thing one session after another. The professor should always be practically engaged in research work, so that his students may have a real example to follow. This of course can only take place when the present disproportionate amount of teaching is reduced. Certain it appears that the enthusiasm and rapid advance of the students working in a German university laboratory is in a great measure, probably entirely, due to the example of the professor's working.

[1] Wundt, "Philosophical Studies," vol. i. p. 473, 1883.

THE CHOLERA BACILLUS

THE Report in which Dr. Koch, chief of the German Scientific Expedition, embodies the results hitherto obtained by him and his assistants with regard to the cholera in Egypt, deals in a very guarded manner with the question of the discovery of a definite cholera bacillus. As the result of experiments carried out both on living and dead cholera subjects, it appears that, whereas no distinct organism could be traced in the blood and in the organs which are so frequently the seat of micro-parasites, yet bacteria having distinct characteristics and resembling somewhat in size and form the bacilli found in glanders were discovered in the intestines and their mucous linings; and this under circumstances which seemed to identify them with the disease from which the patients were suffering. Thus, their existence in the intestinal membranes was obvious so soon after death that they could not have been brought about by any *post-mortem* changes; they were present in the case of all patients who were actually suffering from the disease, and in the bodies of all those who had died of it, whereas they were absent in the case of one patient who had had time to recover from cholera but who had died of some secondary complication; and they were not discoverable in the case of patients who, during the cholera epidemic, succumbed to other diseases. And further, the same bacillus had been met with by Dr. Koch, a year previously, in the case of four patients who had died of cholera in India, and portions of whose intestines had been forwarded to him for examination.

From these circumstances Dr. Koch feels justified in provisionally holding the belief that these bacilli are in some way related to cholera, but as yet he is not prepared to say whether they are the cause or the effect of that disease. The number of cases which the Scientific Expedition were able to utilise for the purposes of their inquiry was very limited, and it is also suggested as possible that some of the experiments were vitiated owing to the circumstance that the disease was already subsiding in intensity when the investigations were commenced. Especially does Dr. Koch suggest that this may account for the invariable failure to produce cholera in any of the lower animals into whose bodies the intestinal secretions were inoculated; but as to this it must be remembered that human diseases are rarely communicable to other animals, and that, as regards enteric fever, a disease which etiologically and otherwise has many points of resemblance with cholera, every effort to communicate it to other mammalia has hitherto invariably failed. But the failure of infective power which may very possibly be associated with the declining stage of an epidemic would be very likely to interfere with experiments having for their object the isolation and cultivation of the bacillus, and hence we are glad to learn that Dr. Koch is to continue his investigations in India, where the varying stages of the disease can easily be met with. In the meantime, however, it will be well to remember that Drs. Lewis and Cuningham have, notwithstanding laborious microscopic and other researches in India, hitherto failed to identify any of the organisms they have met with as specifically related to cholera.

One point is set at rest by Dr. Koch's Report, and that relates to the actual nature of the disease which has been epidemic in Egypt. Both pathologically and otherwise he declares it to be identical with Asiatic cholera.

NATIONAL TRAITS IN SCIENCE[1]

THERE are at present three principal currents of scientific work—German, English, and French. The scientific writings of each nationality are characteristic, and, taken as a whole, offer in each case distinctive qualities. German influence is now predominant over the scientific world, as French influence was uppermost during the earlier part of this century; but the sway of Germany over Western thought is far more potent and widespread than was ever that of France. As students once gathered in Paris, so they now flock to Germany; and thence back to their own lands they carry the notions of German science, and labour to extend, imitate, and rival them. Thus German ideas have been spread abroad, and established in foreign countries. This has set a common standard for scientific work, which is accepted in most European countries. German influence is evident by its effects in Switzerland, Russia, Italy, Poland, Belgium, England, and America, and in degrees indicated by the order given: in France, Spain, and Portugal it is hardly noticeable. Holland and the Scandinavian countries have for many years achieved so much and so excellent work that their scientific development may be said to have accompanied rather than to have followed that of Germany.

German science has unquestionably distinctive qualities. Its pursuit is a special and honoured calling, attractive to the highest talent: its productions have the stamp of professional work. The German scientific man is first and principally an investigator: he is obliged to be so, otherwise he loses in the race. He wins his posi-

[1] From *Science* of October 5.

tion in the hierarchy of learning by the original researches he carries out. To succeed under these circumstances, a man must discover something which is a real addition to knowledge; and to do this, he must be thoroughly familiar with all that has been previously accomplished in his field. Moreover, to advance beyond his peers, the investigator must utilise every possible extraneous advantage; more especially must he have a mastery over the methods to be employed, and be familiar with all novelties and refinements therein. It cannot be gainsaid that these requirements are more fully answered in Germany than anywhere else. It is certain that, excepting of course a small minority, German scientific publications always contain something really new, and unknown before: each article is a scientific progress, which, however slight, still brings an actual increment to our store of information. Another result of this professional thoroughness is equally striking and characteristic. Being fully posted as to the status of his department, the German often displays a singularly just and keen appreciation of what problems are for the moment best worth studying, as being open for solution, and leading to something farther, or else filling a gap left. He is thus enabled to render his work efficient. It is sad to think how much scientific work is wasted because the labour is not wisely directed.

In German scientific writings the excellence of the matter usually contrasts vividly with the defective style and presentation. Indeed, the Germans, despite the superiority of their modern literature, are awkward writers, and too often slovenly in literary composition. Conciseness and clearness are good qualities, which may assuredly be attained by the expenditure of thought and pains; but these the German investigator seems unwilling, in many cases, to bestow upon his pen-work, but follows the easier plan of great diffuseness. Besides this, another defect is not uncommon,—the ill-considered arrangement of the matter. This occurs in all degrees, from a well-nigh incredible confusion, to be sometimes found even in elaborate and important essays, to a slightly illogical order. In this regard, a curious and not infrequent variety of this fault deserves mention. According to the headings of the chapters or sections, the division of topics is perfect; but under each head the matters are tumbled together as if a clerk was contented to stuff his papers in anyhow, if only he crammed them into the right pigeon-hole.

Speaking broadly, the German mind lacks conspicuously the habits of clearness and order. There have been celebrated exceptions, but they were individual. The nation regards itself as having a decidedly philosophical bent, meaning a facility at taking broad and profound views of the known. We venture to contradict this opinion, doing it advisedly. Their profundity is mysticism, their breadth vagueness, yet a good philosopher must think clearly. It is a remarkable but little heeded fact, that Germany has not contributed her share to the generalisations of science; she has produced no Linné, Darwin, Lyell, Lavoisier, or Descartes, each of whom bequeathed to posterity a new realm of knowledge, although she has given to the world grand results by the accumulated achievements of her investigators. The German's imperfect sense of humour is another obstacle which besets him on every path. He is cut off from the perception of some absurdity, like that of Kant's neumenon, for instance. One cannot explain this to him: it were easier to explain a shadow to the sun, who always sees the lighted side. To state the whole epigrammatically, German science is the professional investigation of detail, slowly attaining generalisations.

English science is the opposite of this,—amateurish rather than professional. Some might call it insular, yet we should hardly join them in so doing. In fact, the professional investigator has hardly been a recognised character in the English social organisation: until recently he was barely acknowleged, even by the universities, which sought instructors who knew and could teach, who might investigate and discover in a subsidiary, and, as it were, unofficial way. A large number of English scientific men were disconnected from the universities and colleges after their own student years, and were half or wholly amateurs; and their writings show the effects of this separation, not always, to be sure, but in many cases with painful evidence, by a lack of thoroughness, an imperfect acquaintance with other investigations, and a failure to grasp the essential part of the problem: in brief, such writings appear behindhand and superficial. Yet amid these poorer productions are to be found a right goodly number of the best scientific articles we possess in any language. Of late years the proportion of the good has steadily increased, and investigation is now more correctly appreciated than ever before. Indeed there is no more encouraging event in the recent progress of science than the sudden elevation of the standard of original research in England. The English are trained writers: their scientific articles excel the German in literary merit, being seldom slovenly either in arrangement or style, and rarely wearisome from sheer diffuseness. Very noteworthy is the fertility in generalisations of the English: this is with them the outcome of individual endowments, a single master attaining a broad conclusion—a process of individual effort quite unlike the German democratic method of generalising by the accumulations of many. Is it too much to say that the English and Scotch are the Greeks of modern philosophy?

French science is decidedly provincial: it is apart, having only an imperfect, uncertain acquaintance with the great world outside, and its international interests of original research. The French have lagged far behind the great movements of recent years. Consider only how backward they have been in the comprehension and acceptance of the Darwinian theory; and remember, too, that it were wiser to take out the mainspring from a watch than to eliminate evolution from biology. French scientific articles are well written, the matter is admirably classified, it is all very clear. The keen, artistic sense of the nation displays itself here; but it also deludes them into presenting a rounded survey of a greater field than is demanded by the actual discoveries they report. To satisfy this yearning for artistic completeness, elaborate and tedious disquisitions, and hackneyed principles, and facts long known, are interpolated; and even worse may be, when the imagination helps to create the completeness. Most scientific men harbour a little distrust of French work. This sentiment is further fostered by the almost systematic neglect of German research on the part of the French. Such a frank exhibition of rancour makes one suspect the impartiality of the French in science generally: indeed, we believe that science has never been so depressed in France as at present. Italy is above her; but Italy, with all her innate ability, is striving to learn from Germany, and has already risen high, and will rise higher. We trust and believe that the present phase of French science which abounds in inefficient work will soon end, and the people terminate their present voluntary isolation. The French stay at home: they used to travel abroad much. Let us hope that they will soon resume their ancient habit, and, above all, that they will re-establish mental intercourse with foreigners. There are *savants* in France who are esteemed throughout the scientific world: may their number rapidly increase!

America's contributions to pure science are by no means very extensive, or often very important: compared with the great volume of German production, they seem almost insignificant. We have never duly fostered research, for we have bestowed upon it neither the proper esteem nor office. There are, we suppose, at least six thousand "professors" in the United States: are one hundred and fifty of them active investigators? The time seems remote when every American professor will be expected to be also an investigator; but among us is a little band of men who have before them the model of Germany, and who are working earnestly for the intellectual elevation of their country. Their first object is necessarily to render research more important in public estimation, and so to smooth the way for a corps of professional investigators. Every thoughtful person must wish success to the attempt.

THE GEODETIC CONGRESS

THE most generally interesting part of the proceedings of the Geodetic Conference which has been sitting at Rome during the past week is that connected with the selection of a common first meridian.

The report of the Permanent Committee of the International Geodetic Association recommends to the Conference the general acceptance of the meridian of Greenwich; it was referred to a Special Committee composed of one representative for each of the following—England, the United States, Germany, Italy, France, and Hamburg. The report concludes thus:—

"We terminate our report by proposing to the Assembly the following resolutions:—

"The seventh General Conference of the International Geodetic Association, held at Rome, and in which representatives of Great Britain, together with the directors of the principal astronomical and nautical almanacs, and a delegate from the Coast and Geodetic Survey of the United States have taken part, after having discussed the questions of unification of longitudes by the adoption of an initial meridian, and of the unification of time by the adoption of a universal hour, have come to the following conclusions:—

"Firstly, that the unification of longitudes and of hours is as equally desirable in the interests of science as in those of navigation, commerce, and international communication. The scientific and practical utility of this reform considerably outweighs the sacrifices and the trouble of arrangement to which it will put the minority of civilised nations. It should, therefore, be recommended to the Governments of all the States interested that it may be arranged and confirmed by an International Convention, so that henceforth one and the same system of longitudes may be employed in all the astronomical and nautical almanacs, in all the geodetic and topographical bureaux and institutes, and in all geographical and hydrographical charts.

"Secondly, that the Conference propose to the Governments to choose for the initial meridian that of Greenwich, inasmuch as that meridian fulfils, as a point of departure of longitudes, all the conditions required by science; and that being already actually the most extensively used of all, it presents the greater probability of being generally accepted.

"Thirdly, That the longitudes should be reckoned from the meridian of Greenwich in the sole direction of from east to west, and from zero to 360°, or from zero to twenty-four hours; the meridians on the charts and the longitudes in the registers should be indicated everywhere in hours and minutes of time, with liberty of adding the indication of the corresponding degrees.

"Fourthly, That the Conference recognises for certain scientific needs, and for the service of the great administrations of the means of communication, such as railways, steamship lines, telegraphs, and posts, the utility of adopting a universal hour, side by side with the local or national hours, which will necessarily continue to be employed in civil life.

"Fifthly, That the Conference recommends, as the point of departure of the universal hour and of cosmopolitan dates, the mean noon of Greenwich, which coincides with the instant of midnight or with the beginning of the civil day, situated at the twelfth hour, or at 180°, Greenwich. It follows that the universal time will correspond everywhere with the mean local time, reckoned from midnight, less twelve hours and the longitude of the place, and that the dates change at the antipodes of Greenwich.

"Sixthly, That it is desirable that those States which, in order to adhere to the unification of longitudes and of hours, will have to change their meridians, should adopt the new system of longitudes as quickly as possible in their observatories and official almanacs, in their geodetical, topographical, and hydrographical works, and in their new charts. As a means of transition it would be well that in new editions of old charts, on which it would be difficult to change the squares, the indications according to the new system should at least be inscribed alongside the enumeration of the old meridians.

"Seventhly, That these resolutions should be laid before the Governments and recommended to their friendly consideration with the expression of a hope that an International Convention confirming the unification of longitudes and of hours may be concluded as quickly as possible by a special Conference."

The Report is signed by the president, General Ibanez, and the secretaries, Professors von Oppolzer and Hirsch, the latter being also the reporter.

The paragraph in Dr. Hirsch's report, in which, after considering the question of the choice of an initial meridian, he emphatically conveys the opinion of the Permanent Committee in favour of that of Greenwich, merits quotation:—

"It cannot be doubted that the problem should be solved in favour of the meridian of Greenwich. It is by far the most extensively used, and, from the geographical, nautical, astronomical, and cartographical points of view, best answers the two conditions required. In fact, the immense British Empire, with its 20,000,000 of square kilometres and its 250,000,000 of population, extends over all parts of the world. Its mercantile marine, numbering 40,000 ships, with a total of from 6,000,000 to 9,000,000 of tons, and an equipment of 370,000 men, surpasses in importance the *ensemble* of all other navies. It must also be added that a great many other countries, among which the most important in respect of their mercantile marine are the United States, Germany, Austria, and Italy, equally use the Greenwich meridian in navigation, whence it may be affirmed that 90 per cent. of the navigators throughout long voyages calculate their longitudes by the meridian of Greenwich."

The Report of the Special Committee on the above resolutions was read on the 22nd before the general meeting of the Conference, and accepted, after a very animated debate.

Referring to the resolutions it is only requisite to state briefly that, according to the *Times* report, as sent back to the Conference by the Special Committee, they now stand as follows:—Numbers 1, 2, 4, 6, and 7 were adopted by the Committee without alteration; the other two were modified, or rather abbreviated, and now read thus:—

"Thirdly, that the longitude should be reckoned from the meridian of Greenwich, in the sole direction of from west to east.

"Fifthly, That the Conference recommends, as the point of departure of the universal hour, and of cosmopolitan date, the mean noon of Greenwich, which coincides with the instant of midnight, or with the beginning of the civil day, under the meridian situated at 12 hours, or 180°, from Greenwich; the universal hours to be counted from zero to 24."

To these seven resolutions the Special Committee have added two others. The first, inserted between numbers one and two of those referred to, reads thus :—

"That, notwithstanding the great advantages which the general introduction of the decimal division of the quadrant for geographic and geodetic co-ordination, and the corresponding expressions for time, is destined to realise, scientifically and practically, reasons eminently sound appear to justify the passing by the consideration thereof in the great measure of unification proposed in the first resolution. Meanwhile, to satisfy at the same time important scientific considerations the Conference recommends on this occasion the extension, in multiplying and perfecting the necessary tables, of the application of the decimal division of the quadrant, at least for the great numerical calculations for which it presents incontestable advantages, even if it be desired to preserve the old sexagesimal division for observations, maps, navigation, &c."

The other, inserted between resolutions six and seven, is as follows :—

"The Conference hopes that, if the whole world is agreed upon the unification of longitudes and hours in accepting the Greenwich meridian as the point of departure, Great Britain will find in this fact an additional motive to take on her side new steps in favour of the unification of weights and measures, by joining the Metrical Convention of May 20, 1875."

The resolution as to the choice of the initial meridian was carried by 22 votes to 4; while Mr. Christie, supported by the French delegates, moved the substitution of Greenwich midnight for noon as the point of departure; this amendment was negatived by 20 votes to 8. Finally, Dr. Hirsch made a motion, unanimously carried, to the effect that the Conference should request the Government of His Majesty the King of Italy to officially communicate the resolutions voted by the assembly to all the Governments, including those not represented at the Conference.

Among other reports read was one by Dr. Hirsch, on the works of precise spirit levelling carried out in different States during the last three years. Col. Perrier, one of the French delegates, recommended that those works should be continued, so as to connect the Atlantic with the Pacific, and to ascertain the difference of level between those two oceans. General Ibanez read a report on tidal studies with the mareograph. An interesting discussion followed as to the best means for obtaining the most exact results, and a proposal made by General Ibanez to exclude observations taken at times when the sea is agitated was accepted.

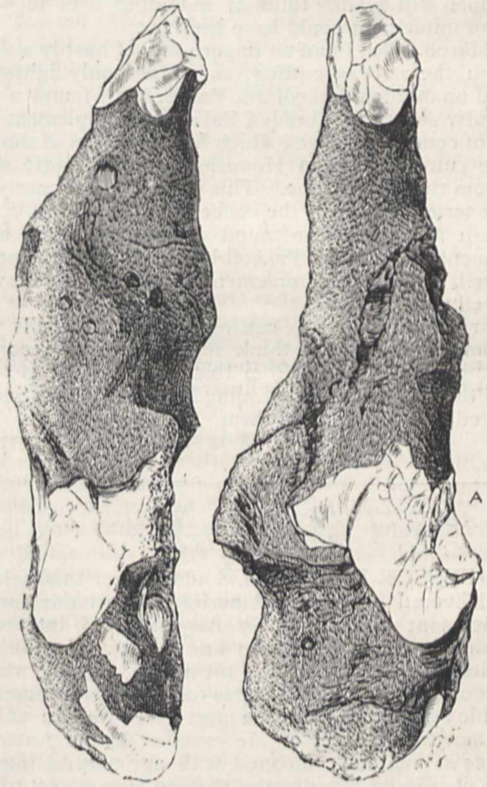
Col. Ferrero proposed to close the network of triangles around that basin of the Mediterranean of which Italy forms the eastern side, and invited France to connect the Algerian network with the Italian at Tunis as quickly as possible. Col. Perrier replied, giving assurances that France would commence the work next year, and then read his report upon the measure of bases and the instruments employed, which concluded with a request that the Geodetic Association would invite Germany to prevent the destruction of geodetic signals.

A Committee, composed of Col. Clarke on the part of England for Malta, Capt. Kalmar for Austria, Col. Perrier for France, and Capt. Magnaghi, Col. de Stefanis, and Prof. Pergoal for Italy, were charged with the establishing of an accord for the trigonometrical junction of Italy with France, and Austria and Sicily with Malta, and instructed to invite the co-operation of England in communicating differences of longitudes to be determined telegraphically between Malta and Bona, between Malta and Naples, between Naples and Corfu, &c.

The honorary president of the Conference was General Baeyer, and the acting president Col. Ferrero, President of the Italian Geodetic Commission. Mr. Christie, the Astronomer-Royal, and Col. Clarke, R.E., represented England at the Conference. The United States was represented officially by General Cutts of the Coast Survey, though Messrs. Hilgard and Peirce seem also to have been present.

LARGE AND RUDE PALÆOLITHIC IMPLEMENT

IN November, 1881, Miss Eleanor A. Ormerod, F.M.S., of Isleworth, found the remarkable instrument here illustrated, and kindly added it to my collection. It was found in the gravel and brick-earth thrown out of an excavation made for the new Hounslow and London Railway, immediately south of Osterley Park, near Isleworth. The excavation at this spot showed about three feet of brick-earth resting on eight feet of gravel, and at this depth the London clay was reached, a foot or two of which was exposed. The gravel showed horizontal seams



of fine sand, and agreed well with the well-known Thames gravel at Acton and Ealing.

The implement is engraved one-sixth actual size, and a front and side view are shown. It is exactly two feet in length, and weighs thirty-two pounds. It belongs to the gravel and sand, and is Palæolithic, as is proved by the ferruginous stains. Miss Ormerod, who saw that the flint had been trimmed to shape by human hands, took the instrument to be a huge club, the more attenuated end being possibly, she thought, designed for grasping in the hands; she also noticed that the more massive end was battered as if by use as a club. The more pointed end of this tool has been rudely but skilfully trimmed to a wedge-like point, and any one acquainted with flaking can see at a glance by referring to the illustration that the point is artificial. Towards the base at A (seen more distinctly on the right of left figure at same point) the battering is remarkably distinct. I do not think this battering has arisen from the use of the tool as a club, but rather as an anvil, as pointed out more than once in reference to other stones observed by Mr. F. C. J. Spurrell and myself. Several flakes have been removed from the extreme butt, and a few small inconvenient asperities have been knocked off elsewhere. Greater part of the flint is covered with the original bark, and this bark is brownish ochreous, its colour proving its derivation from the ochreous gravel. The trimmed parts are lustrous, unabraded, and very slightly stained. The tool was no doubt made and used close to where it was found, and probably belongs to a "Palæolithic Floor," of which so many examples are known now that attention has once been drawn to them. The whole condition of the implement exactly agrees with the stone implements from Stoke Newington, Erith, and Northfleet. The tool appears to have been used as an instrument for thrusting, as well as in a horizontal position as an "anvil-stone." It would be idle to mention the possible uses of such a huge tool as this, but every one who has formed ideas of the mode of life of Palæolithic men will readily think of numerous uses to which such an implement could have been put.

In March, 1882, I had an opportunity of hastily walking through the railway cutting, and I not only lighted on several unabraded Palæolithic flakes, but I found a subtriangular somewhat abraded Palæolithic implement in a lump of concreted gravel, which had fallen out of the side of the cutting between Hounslow and Isleworth at six feet from the surface line. This implement, formerly 556 in my series, is now in the collection of Mr. John Evans at Nash Mills. I also found a large butt-end of an implement, broken in Palæolithic times, a little nearer Hanwell, and another implement in the cutting between Hanwell and Ealing.

Near Hanwell in this cutting fresh-water shells were abundant, and I do not think they have been recorded, with implements, before from this position. It is to be hoped the members of the Ealing Natural History Society collected and took note of them.

WORTHINGTON G. SMITH

AGRICULTURE, ITS NEEDS AND OPPORTUNITIES

PROFESSOR W. J. BEAL'S address on this subject, delivered before the American Association for the Advancement of Science, in August, is of interest to Englishmen from more than one aspect. In the first place its perusal gives us the means of knowing what is being done in the United States for the advancement of scientific agriculture. In the next place we are able to judge how far we excel or are excelled by our American relatives in matters connected with agricultural inquiry. Lastly, it is in such addresses that we may expect to find suggestions worthy of attention, and thoughts which in due course will develop into acts. Prof. Beal takes for his text—"Agriculture, its Needs and its Opportunities." So far as its needs go they are manifold, and its opportunities are certainly coextensive with its vast domain.

The first need is a very common one indeed—it is the need of brains. Agriculture needs brains to guide and counsel her. Prof. Beal is evidently a man calculated himself to supply this need so far as one man can so do. He invites the assistance of men of intellect to rescue agriculture, and he laments the fact that within a comparatively recent time but very little of the best thought even of civilised nations has been devoted to subjects intended to advance agriculture. He calls attention to the munificent aids granted by the United States Government for the encouragement of anthropology, astronomy, geological and mineralogical and other surveys, while but a small sum has been appropriated to agriculture. To illustrate the hesitancy of men to bequeath money for the promotion of agriculture he takes the following from an address given by President T. C. Abbot:—

"I met a very pleasant and intelligent gentleman, who, from his large wealth, was about to give some sixty or seventy thousand dollars for the advancement of higher education. He had been for some years, and was still, the president of a State Agricultural Society. He was a farmer. Did he then endow some Chair of Agriculture or Agricultural Chemistry, of Veterinary Science, or of Horticulture? Did he fit out an experiment station to analyse fertilisers, to study the value of cattle foods? None of them. This farmer gave his thousands to endow another workshop of astronomy."

The above sentences are couched in the language of indignation. They illustrate our own experience on this side of the water, for the public ever seem to take more interest in abstract science and fine art than in technical instruction. The interest in agricultural science has been always languid, albeit it has had its stalwart and enthusiastic supporters. But the public have hitherto failed to tangibly grasp the importance of the subject. It is allowed in a sort of languid and perfunctory manner, but without enthusiasm. We have recently passed through a fervid effort towards the attainment of better musical instruction by means of a College of Music. But when are Royal personages going to lead a movement in the direction of securing better instruction in agriculture? And is not agriculture as noble a subject whereon Royalty might bequeath its patronage and lavish its wealth as music?

We find then a certain unaccountable indifference to agricultural science on both sides of the Atlantic, and yet we ought not to forget that, while much more ought to be done, much has been done both in America and Europe.

The field as a field of research has not been so fruitful as at one time it was expected to prove. The old and time-honoured practices of the farmer have too often justified themselves when confronted by scientific objectors. The suggestions of the scientific man have too often been found impracticable and over-expensive by the practical farmer.

It is indeed very difficult to improve upon processes which have stood so many trials. A certain reckless assumption that old practices *must* give way to new has been the ruin of many good men. Agriculture is undoubtedly capable of improvement, but the improvement is generally most evident when established upon the old lines of good practice, and when heroic measures are avoided.

Limited production is the chief difficulty in the way of scientific agriculture. We cannot multiply our production by steam power or chemical fertilisers. We can only add to it, and that rather sparingly. We cannot increase the number of our crops. Harvest only comes once a year. Thus the examples of the printing press and of the loom fail to impress the farmer with what science is to do for *him*. Let it not, however, be thought that there is not scope for the application of science to agriculture. If we cannot multiply we can increase our produce and cheapen processes. The uses of fertilisers; the comparative values of foods; the improvement of instruments; the introduction of steam; the propagation of improved animals; the study of grasses and economic plants in general; the improvement of wool and of cereals; the introduction of new and cheap building materials, &c., are all worthy of attention, and all require the aid of science.

Prof. Beal points out the importance of meteorology to the farmer. He illustrates this by a quotation from Dr. R. C. Kedzie, who wrote in 1882, "If specific warnings had been given our farmers at that time (harvest), most of the wheat might have been safely housed, and the farmers of Michigan saved from a loss of $1,000,000." Another point made by the professor refers to our imperfect knowledge of those epidemics which from time to time visit our own flocks and herds, as well as those of America—

"Among the drawbacks that may be specially named is the ignorance of legislators, of executives, and electors on this subject."

With this English readers will entirely concur. The next subject proposed as a definite object of study is that of economic entomology. Such enemies as the Colorado beetle, the wheat midge, the turnip fly, the wire worm, or the locust are among the most formidable which the farmer has to contend with. The depredations of the wheat midge alone may be appraised at over 3,000,000 bushels annually in Great Britain. Our Royal Agricultural Society has taken up this matter, and Miss Ormerod's book upon injurious insects is full of information and suggestions concerning it. This certainly is a branch of knowledge which requires labourers. From it we are led to reflect upon the important bearing of the study of *entozoa* upon agriculture, and especially upon the pathology of farm stock. The improvement of the American pastures appears to be desirable. According to Prof. Beal, a dozen sorts of grasses probably cover nineteen-twentieths of all the cultivated meadow-land from Maine to Texas. As the grass family is large, containing from 3100 to 4000 or more species, it is naturally thought that a few more might be found suitable for various parts of this immense area.

Not only is much to be done in the introduction of new grasses but in selecting and propagating varieties of the same grass. "Plants of red clover vary amazingly in many respects." "I believe our fields of red clover to-day contain nearly or quite as great a variety of plants as would a field of Indian corn, if we were to mix in a little seed of all the varieties cultivated in any one State." This is startling, but quite in accord with the wonderful variations observable in plants of Italian and perennial rye grass and other grasses and clovers. Thus Prof. Beal indicates various paths for improvement, and urges the vast importance of agricultural experiment stations, where work bearing upon the various subjects enumerated may be carried on by competent persons. There is nothing very new in all this. The importance of agricultural research has been often declared in our own country from the days of Sir Humphry Davy until now; but too often the voice has been as of one crying in the wilderness. Some good has been done, and we may expect a more rapid development of these ideas ere long. Scientific agriculture was never more popular than at present, and the number of agricultural students attending systematic courses of instruction is greater now than at any previous time. Agriculture has become a recognised subject of the Science and Art Department, and we note a disposition on the part of scientific men to attach greater importance to the study of domesticated animals and cultivated plants than formerly. We owe much of this to Darwin. He, more than any other man, raised the scientific interest of these humbler subjects of zoological and botanical science, which had previously been passed by scientific men with scarce concealed contempt. Anthropology has also done much to throw a halo of interest around those animals and plants which have been associated for long ages with man. Hence there is a greater bond of union between the present generation of scientific men and the agriculturist than existed a generation since, and it is probable that this sympathy will increase and fructify for the benefit of all.

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THE GREAT NEBULA IN ORION

IT is a fortunate circumstance for students of nebular astronomy that within a short time that branch of science has been enriched by a monograph and a photograph, each perfect in its way, of one of the grandest objects in the heavens. The monograph is from the pen of Prof. Holden,[1] whose name is a guarantee of thoroughness; the photograph we owe to Mr. Common, who at one bound has distanced all predecessors, and has shown us that in the future we may hope for permanent records of the nebulæ as perfect as those of the surfaces of the sun and moon produced by Janssen and Rutherfurd.

In the present article we propose to refer to both these productions with a view of showing how terribly physical astronomers are losing time in not throwing all their energies into the production of photographic records whenever possible. In Prof. Holden's paper we are enabled to see how, two hundred years ago, time was lost and false issues raised because the astronomers of those days had never learned to draw; indeed it is terrible to look at the collection of rude, crude, and almost impossible sketches by Huyghens, Mairan, Picard, Long, Le Gentil, and others which he has brought together. Mr. Common on his part has shown us that it is possible to photograph, with about half an hour's exposure, all the details shown in the most careful drawings made by men with artistic training as the result of months—and we may almost say years—of labour; such drawings as we owe to Bond, Herschel, and Lord Rosse. Mr. Common's photograph, it should also be said, includes the whole nebula, while the monograph is confined to the central portions.

The most convincing argument, however, in favour of the more serious employment of photography in our observatories, that we can use is to show the relation of the photograph to the memoir. The latter commences as follows:—"The main object of this memoir is to leave such measures and descriptions of the brightest parts of the nebula of Orion as shall enable another person observing in after years with the same telescope, under like conditions, to say with certainty whether or no changes have occurred in those parts of this nebula."

To carry out this object everything touching the nebula written between 1618, when Cysat of Lucerne discovered it, and Holden's own observations of 1881 has been brought together and coordinated, and the labour and time this has required may be gathered from the fact that the list of the more important papers relating to the nebula consulted in writing the memoir cover four pages quarto and includes about two hundred entries.

Now it is not too much to say that in the case of an astronomer taking up the question a century hence, as Prof. Holden has now done, he would prefer the single photograph taken by Mr. Common in thirty-seven minutes to all the literature so admirably brought together by Prof. Holden; and if the world must in the meantime lose either the memoir and the records of the human effort of 2½ centuries on which it is based, or the photograph, then it is to be hoped that the photograph will be spared. We say this the more readily because we are certain that Prof. Holden will agree with us.

But it is time that we should refer to the memoir separately. It is preceded by Bond's magnificent drawing, 1859-63, and an index chart giving the minute system of nomenclature necessarily adopted to distinguish the various bright masses, dark channels, spirals, &c., of the portion under notice. The nomenclature is that of Sir John Herschel, Lord Rosse, and Liaponoff in the case of the nebula proper, while the stars are laid down from Bond's catalogue. The index map is indeed the only part of the memoir with which we have any fault to find, for it attempts too much, and for that reason will be of restricted use to those whose optical power is not of the greatest.

The drawings and memoirs are considered in chronological order; the woodcuts bring up the drawings to the same scale, or nearly so. We have the woodcut first, and then extracts of the *ipsissima verba* of the observations. Everything touching the central portion is given

[1] "Washington Astronomical and Meteorological Observations," vol. xxv., 1878. Published 1882.

fully, generally in the words of the author, including discussions as well as original observation; so, as the author points out, the admirable *résumés* of Liaponoff, Struve, D'Arrest, and others are available for immediate reference.

Although Cysat of Lucerne discovered the nebula, it was not the first discovered, that in Andromeda having been noticed by Abdul Rahman al Sûfi, A.D. 950, nor were Cysat's observations of much value. The observational work really dates from 1656, when Huyghens independently observed it, and recorded roughly, as we have said, its shape and the included stars. After all we must not be too hard on the early observers, for, according to Arago, Huyghens' telescopes of 2⅓ inches diameter were 12 and 23 feet long, power 48; drawing *at the telescope*, therefore, was almost out of the question. This notable observation did not long escape our own keen-eyed Hooke, who added to the triad of stars in the central part of the nebula two others, and henceforward the little stellar group has been called the "trapezium," and is a test object dear to all amateurs. Hooke's telescope was 36 feet long, aperture 3½ inches. Huyghens, in his later observation (1694), also caught the fourth star.

After this time the nebula and the number of its included stars grew and grew with every increase of optical power.

FIG. 1.—The Great Nebula in Orion (from a photograph by Mr. A. A. Common).

The observations of Mairan (1731), Long (1742), Le Gentil (1758), Messier (1771), and Sir Wm. Hershel (1744–1811) follow next, the latter especially giving considerable attention to the nebula with his gigantic reflectors; and indeed it may be said he was the first to seriously study it, and among the results of his observation was the statement that the nebula had undergone changes during the time he had been studying it. The three points insisted upon by Herschel are carefully discussed by Holden, with the result that he considers none of them to be established.

Interpolated between the observations of Sir Wm. Herschel and his son (1824) are those of Schrœter (1794–98), Lefebvre (1799), Bode (1800), and Flaugergues (1802).

In Sir John Herschel's first memoir the accepted nomenclature is established; this is partly shown in the annexed sketch.

Like his father Sir John Herschel discussed the question of change. "To the reader who has never viewed this object through powerful telescopes, but who is familiar with the various representations which have from time to time been made of it (including my own of 1824), the number and complexity of the various branches and convolutions now first exhibited, and the different aspects under which the portions best known are now presented, will no doubt tend to convey a strong impression of great and rapid changes undergone by the nebula itself. I am far from participating in any such impression. Comparing only my own drawings made at epochs (1824 and 1837) differing by thirteen years, the disagreements, though confessedly great, are not more than I am disposed to attribute to inexperience in such delineations (which are really difficult) at an early period —to the far greater care, pains, and time bestowed upon the later drawings. . . . Now there is only one particular on which I am at all inclined to insist as evidence of change, viz., in respect of the situation and form of the *nebula oblongata*, which my figure of 1824 represents as a tolerably regular oval. . . . No observer now, I think, looking ever so cursorily at this point of detail, would represent the broken, curved, and unsymmetrical nebula in question . . . as it is represented in the earlier of the two figures."

The enormous body of work done even in Sir J. Herschel's time, chiefly by Lassell, Bond, Liaponoff, Struve, and Lord Rosse, is so fully recorded that it is impossible to do more than refer to it in the space at our disposal, besides which much of it is so recent as to be still in the minds of all interested in such questions. But

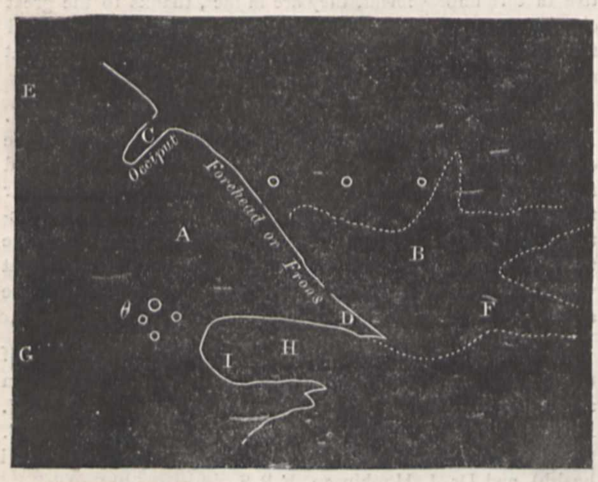


FIG. 2.—Sketch Map of the Huyghen'an Regicn.—A, the Huyghenia (brightest) region; θ, the four stars of the Trapezium; B, subnebulou region; C, Sinus Gentilii; D, Rostrum; E, Regio Gentiliana; F Regio Messieriana—Brachium Messieri, Proboscis Major; G, Regio Derhemiana; H, Sinus Magnus; I, Schrœter's Bridge.

Mr. Holden, in his work on the nebula, has not contented himself with discussing this work merely. The Washington observations made by himself are given, and cover nearly 100 pages.

We may now deal with the results arrived at. Prof. Holden considers the evidence of change undoubted, but such change depends less upon actual change of form than upon shiftings of the maxima of brightness. The most undoubted changes are in the brightness of the first and second Schrœter's bridge, and in the appearance of the nucleus of the first. The changes in the brightness of some of the masses are established by the Washington observations alone. Among the results of these observations is a new nebulous patch seen from the time of its origin, when it was stellar in appearance, and faint, until now, when it is bright, and of measurable dimensions.

Another matter investigated by Prof. Holden is the question of the connection of the stars with the nebula. On this point spectroscopic work is brought upon the scene. The spectrum of the nebula was first studied by Huggins. The gaseous nature of some of the small stars near the trapezium is, Prof. Holden thinks, indicated by their peculiar behaviour under different magnifying powers; some of them are best seen with low powers.

The question of photography is introduced in an appendix giving the results obtained by the late Dr. Draper just before his lamented death. This photograph was exposed for 137 minutes, and, as may be easily imagined, lacks sharpness, but still, as Prof. Holden puts it, it worthily inaugurated nebular-photography. He also clearly pointed out that, since the eye and the salts of silver do not most strongly respond to light of the same wave-lengths, the intensities of drawings and photographs must vary, and he shows that they do vary. On the other hand, it is shown that the untouched photograph defends the best drawings against the charge of depending too much upon the personal equation of the observer, as over large regions the best drawings are justified by the photograph.

Mr. Common's photograph, a reproduction of which we give, is far finer than Dr. Draper's, among other reasons because it was exposed for about one-third the time. It is to be hoped that we shall have photographs as good as this taken for the future every year, not only on plates responding to blue light, but on plates responding to green and red. In this way most precious records will be secured for future discussion.

On this question we may make the following quotation from Mr. Common's communication to the Royal Astronomical Society:—

"To find if there is any change of form or relative brightness observable in a nebula with any degree of certainty, it will be necessary to compare photographs taken at some undetermined interval of time; and the best thing to do now seems to me to be to get as many photographs as possible to form the basis of comparison with those taken at some future time; and this I am now doing. . . .

"The light of this nebula is so different in intensity that for a proper exposure of the outer portions the central part is much over-exposed; it is therefore necessary to take photographs with different exposures. Thus an exposure of from one to three minutes gives the brighter portions of the central parts in such a way that they can be easily compared and their order noted; longer exposures giving portions less bright in a similar way, till, with a maximum exposure, the very faintest portions can be compared and noted in order. The stars in the nebula can be treated in the same way, the same photographs being available."

We have before referred to the fact that many of the stars in and about the nebula are variable, particularly the faint ones. Mr. Common has found that one of the brighter stars is remarkably variable, though what its period is he has not yet determined.

As the time of exposure can be easily extended to hours, it will evidently in the not distant future be easy to get stars invisible to the eye in the same telescope used for photography.

NOTES

AMONG the gold medals awarded by the juries of the International Fisheries Exhibition are the following in the department of Natural History:—INVERTEBRATA.—United Kingdom: James Cook, the Duke of Edinburgh, Prof. McIntosh, Thos. Bolton. Italy: Dr. Dohrn (2). Netherlands: Netherlands Zoological Society. United States: United States Fish Commission. New South Wales: Sydney Museum. Sweden: F. B. Wittrock, Baron Nordenskjöld, W. Lilljeborg. Russia: Dr. Oscar Grimm. FISH, &c.—United States: United States National Museum, United States Fish Commission, Prof. Alexr. Agassiz, Prof. G. Brown-Goode, Prof. David S. Jordan. New South Wales: Australian Museum, Sydney (2); New South Wales Commission, Hon. W. Mackay, E. P. Ramsay. Sweden: the Royal Swedish Academy, Dr. Oscar Dickson. Canada: Canadian Government. China: Government of.

Norway: the Government Geographical Survey. Tasmania: Commissioners of Fisheries. United Kingdom: Dr. F. Day (2), the Princess Louise, Rd. Collett, Dr. Francis Day, Mrs. Bleeker, Arthur Grevenstuk. Sweden: Prof. Baron A. E. Nordenskjöld, Prof. F. A. Smith, W. von Wright. Denmark: H. V. Feilder. Norway: Prof. G. O. Sars, Prof. H. Mohn. MAMMALS, BIRDS, &c.—India: Bombay Museum. Canada: Canadian Government. United States: United States Fish Commission. Sweden: Oscar Dickson, Stockholm Museum, Baron Nordenskjöld.

BEN NEVIS OBSERVATORY was duly "inaugurated" on Wednesday last week amidst a snowstorm. The ceremony passed off successfully, Mr. Murray formally accepting from Mrs. Cameron Campbell, the proprietress of the ground on which the Observatory is built and over which the road is made, the key of the buildings, which all present seemed to think well adapted for their purpose.

THE Home Secretary has acquainted the Meteorological Society that Her Majesty has been graciously pleased to grant it permission to adopt the prefix "Royal." The Society accordingly becomes the "Royal Meteorological Society." To all workers in meteorology, whether Fellows of that society or not, this public recognition of the importance of the science cannot but be most gratifying.

PROF. EDWARD HULL, F.R.S., Dr. E. Hull, and Mr. H. Hart have left London for Suez, under the auspices of the Palestine Exploration Society, to explore the valley of the Jordan. At Suez we understand that the party will have the advantage of the experience of a member of the firm of Messrs. Cook, under whose guidance the expeditionary party are then to proceed. During Prof. Hull's absence from Ireland the lectures on geology in the Royal College of Science, Dublin, will be delivered by Mr. A. B. Wynne, late deputy superintendent of the Geological Survey of India.

IT is suggested that the memorial to the late Prof. Jevons might take the form of a studentship, of the annual value of not less than 100*l*., the holder of which shall devote himself to economic or statistical research; and that to commemorate the connection of Jevons with Liverpool, in which he was born, and with Manchester and London, in which so many of the best years of his life were spent, the election to the studentship be vested in representatives of University College, London, Owens College, Manchester, and University College, Liverpool, to be appointed for the purpose. Among the members of the committee formed for the purpose of forwarding the proposed memorial are—the Duke of Devonshire, the Duke of Westminster, the Marquis of Hartington, M.P., the Earl of Derby, the Earl of Kimberley, the Bishop of Manchester, Lord Windsor, Mr. Chamberlain, M.P., Sir R. Cross, M.P., Sir Charles Dilke, M.P., Mr. Childers, M.P., Mr. Fawcett, M.P., Mr. Mundella, M.P., Sir J. Lubbock, M.P., Sir T. Brassey, M.P., Mr. J. Cross, M.P., Mr. L. Courtney, M.P., Mr. Robert Giffen, Prof. T. E. Thorpe, Prof. Caird, Prof. J. S. Nicholson, Mr. W. Knight, Prof. Marshall, Principal Edwards, Principal Peterson, Rev. R. Harley, Prof. W. Dallinger, Prof. Adamson, Prof. Roscoe, Prof. Balfour Stewart, Prof. W. Wallace, Prof. G. H. Darwin, and Prof. G. Carey Foster. Subscriptions may be paid to the credit of the treasurer of the Jevons Memorial Fund, with the Manchester and Salford Bank (Limited), and will be received, among others, by Messrs. Williams, Deacon, and Co., London.

AN improvement so useful and suggestive as to deserve notice in these columns, has been recently applied by the proprietors of "Bradshaw's Railway Guide" to the map of Great Britain which accompanies that indispensable manual. It consists in ruling meridian lines at every $1\frac{1}{4}°$ of longitude, or every 5m. of time from Greenwich, so as to show at a glance, sufficiently nearly for practical purposes, the difference between the local time at every town in the United Kingdom, and Greenwich or railway time. The difference, it is true, is small enough to be neglected in the eastern counties; but is considerable enough to require to be remembered in the western half of these islands. A traveller leaving Falmouth by night train with an appointment in London for 10 a.m. the next morning, may be much inconvenienced if he forgets that 9h. 40m. by his watch is 10 a.m. for his purpose. We have only to suppose our traveller to be going from New York to Chicago or from Paris to Vienna, to see the great convenience of this unobtrusive addition to railway maps. But there is another advantage which will be realised whenever these time meridians replace meridians of longitude on school maps, as they are bound to do by degrees. It is that they tend to give clear ideas of longitude, of the earth's diurnal revolution, of time itself. Meridians, as such, are mere coordinates of position, and have no necessary connection with time, and the ideas of many even educated people are extremely hazy on their mutual relations. Messrs. Blacklock of Manchester probably make no pretension to be educational reformers, but in taking the initiative in this improvement, they are in fact, thanks to the great circulation of "Bradshaw," helping to prepare the public mind for the adoption of a universal first meridian, and giving great assistance to the schoolmaster.

THE red spot on Jupiter continues to be well visible. Mr. W. F. Denning writes that on the mornings of October 16 and 18 he observed the spot with a 10-inch reflector, power about 212, and found it a tolerably easy object, though it is very much fainter than the belts. At times the shape of the spot could be distinctly made out notwithstanding the constant vibration of the telescope by the high wind prevailing. Mr. Denning adds that with favourable atmospheric conditions this marking ought to be an easy object for telescopes above 6 inches aperture.

THE only changes proposed to be made in the constitution of the Council of the Mathematical Society for the ensuing session are the substitution of Messrs. W. D. Niven, F.R.S., and J. Hammond, M.A., in the place of Mr. C. W. Merrifield, F.R.S. (who, we regret to say, is obliged to resign on account of ill health), and Dr. J. Hopkinson, F.R.S.

SCIENCE CLASSES have been established in Warwick during the past week. A largely attended public meeting was held on the 16th, under the presidency of the mayor, when an address on the value of science teaching was delivered by the Rev. W. Tuckwell. Fifty names were announced for an immediate chemistry class; and it was proposed to form general classes in geology or botany, with a special working-men's class in practical geometry and elementary mechanics.

MR. J. G. BAKER of the Kew Herbarium, the president of the Yorkshire Naturalists' Union, who has already written floras of North Yorkshire and of Northumberland and Durham, is intending to print this winter a flora of the English Lake District, on which he has been long engaged, and will be glad to receive any contributions towards it.

FROM *Science* we learn that a number of gentlemen met in the library of the American Museum of Natural History in New York City, on September 26 to 28, and founded the American Ornithologists' Union. The membership consists of active, foreign, corresponding, and associate members. The active membership is limited to fifty residents of the United States and Canada; the foreign, to twenty-five non-residents of the United States and Canada; the corresponding, to one hundred residents of any country; the associate being composed of any number of residents of the United States and Canada. The officers of the

Union for the current year are: Mr. J. A. Allen, president; Dr. Elliott Coues and Mr. Robert Ridgway, vice-presidents; Dr. C. Hart Merriam, secretary and treasurer; Messrs. S. F. Baird, George N. Lawrence, H. W. Henshaw, and Montagu Chamberlain, councillors—these nine officers constituting the Council of the Union. The work of the Union for the present year was laid out by the formation of committees on the subjects of classification and nomenclature, of the distribution and migration of birds, of avian anatomy, of oology, and on the question of the eligibility or ineligibility of the European sparrow in America. The first-named committee, besides revising the current lists of North American birds, is expected to consider the subject of zoological nomenclature at large, and its labours may result in the formation of a code of nomenclature applicable to other departments of zoology, as well as to ornithology. It consists of Messrs. Ridgway, Allen, Brewster, Henshaw, and Coues.

THE following telegram from Lieut. Ray, commanding the Point Barrow observing party, appears in the American papers:—"San Francisco, October 7, 1883.—I report my safe arrival here to-day with party. Also brought down Lieut. Schwatka and party from St. Michaels. All work accomplished as ordered by chief signal-officer. Pendulum observation not made. *Leo* reached Ooglaamie August 22; was driven away by ice the same night; returned on the 24th; again driven away and damaged on the 25th; returned on the 27th, when party and stores were embarked; sailed on the 29th, vessel leaking badly; put into Unalaska, where she was beached and repaired."

THE *Dijmphna*, which we announced last week had arrived at Vardö, got free of the ice the day after the members of the Dutch meteorological expedition departed, but having the misfortune of breaking the blades of her propeller she became unmanageable, and was again frozen in for about six weeks. At last, on September 13, the vessel again became free, when Hovgaard succeeded in a week, by sailing and towing, in reaching the Kara Straits, after having passed through ice for some 120 miles. In the latter locality he weathered a terrific storm, and it was first on September 21, in 71° 17′ lat. and 55° 52′ long., that the vessel got quite clear of the ice, viz. half way between the Kara Straits and Vardö, where she arrived after a sixteen days' stormy journey. After repairing here the *Dijmphna* will proceed to Copenhagen. Lieut. Hovgaard and Dr. Holm have made some valuable scientific discoveries and collections during their wintering in the Kara Sea, of which locality a map has also been made.

THE new island which the Dutch Meteorological Expedition discovered near Waigatz Island, is situated in 70° 25′ 28″ lat., and has been named Buys-Ballot Island, after the eminent Dutch meteorologist of that name.

THE expedition despatched by Mr. Sibiriakoff, the Russian merchant, under Mr. R. J. Runeberg, in order to explore the River Angara, between Irkutsk and Yeniseisk, a distance of 1700 versts, has recently returned to St. Petersburg. For several years little ships, chiefly loaded with tea, have sailed down the river, and last year even a small steamer passed down, but shallow rapids have hitherto prevented vessels proceeding up the river. Mr. Runeberg reports that the latter can easily be removed, and a regular trade on the River Angara may therefore soon be looked forward to.

THE native town of M. Pasteur has done honour to the eminent biologist by placing a plate on the house where he was born, commemorating the fact.

VERY few lake-dwellings have hitherto been found in England, and therefore the recent discovery of what seem well-preserved relics of such structures at Ulrome, Holderness, Yorkshire, is of unusual interest. An article in the *Standard* of October 20 describes what has already been done to bring the remains to light, and ascribes the structures and their contents to the early part of the Neolithic age and downwards to the Bronze age.

MR. LEONARD COURTNEY, M.P., speaking at the distribution of the Science and Art prizes at Penzance last week, dwelt strongly on the benefits likely to accrue to the nation from the general study of science. He hoped the study of science would become such that even statesmen might feel the folly of endeavouring to work against the laws of nature.

THE general monthly meetings of the members of the Royal Institution of Great Britain will be resumed on November 5, at 5 p.m., for the election and nomination of members and the election of a manager in the room of the late Mr. William Spottiswoode, P.R.S.

MR. CLEMENT L. WRAGGE, late of Ben Nevis Observatory, sailed on the 18th inst. for Adelaide on the s.s. *Maranoa*. He takes a large equipment of meteorological, surveying, and astronomical instruments, including a fine equatorial telescope. The voyage will be made a scientific one in every possible way, and important results may be expected.

WE understand that the Committee appointed by the Lord Lieutenant of Ireland to inquire into the administrative arrangements of the Board of Intermediate Education will meet in Dublin this week. The Committee consists of Sir R. Kane, Col. Donnelly, R.E., and Mr. R. W. A. Holmes.

SHOCKS of earthquake were felt at a quarter to one o'clock on Friday night at Huelva, Cadiz, Medina Sidonia, Jerez, and other districts of Andalusia along the ocean coast. The movement was from east to west. Telegrams from Huelva and Cadiz say a rumbling noise accompanied the earthquake, which is said to have lasted three seconds in some places, and five seconds in others. In Cadiz the shock is described as strong enough to move doors and bells. The weather, which was unusually wet with cold winds early in October, had lately become very mild and warmer in the south of Spain. Several slight shocks of earthquake were felt on Saturday morning in Lisbon. A shock of earthquake, lasting three seconds, was felt at Tangier at half-past one on Saturday morning. Two shocks of earthquake were felt on Monday morning at Belluno, at the foot of the Dolomite Mountains. The first was at 3.35, the second at 4.15 a.m. Much alarm was caused, but no damage was done. It will be remembered that Belluno suffered great destruction from the earthquake of June 29, 1873. A slight shock of earthquake was felt at Malta at two o'clock the same morning. A slight shock, attended by an undulatory motion, was also felt at Trieste at half-past three the same morning. A despatch received by the Admiralty, dated Tchesme, October 21, states that slight shocks of earthquake continue, but do not cause more damage. Eleven towns and villages have been damaged or destroyed. Lyddia, Eritra, Reisderch are in total ruins Tchesme, Latyalka much damaged. About 90 people were killed, 200 wounded, and 3600 houses destroyed.

MR. H. CECIL of Bregner, Bournemouth, writes under date October 22:—"I perceived here on the morning of the 10th inst, just before the light was sufficient to show the hands of a watch, two distinct tremors of earthquake. A whatnot by my bedside trembled throughout, and a watch on its stand vibrated with a strong and regular pulsation. Nothing was passing at the time, and a heavy steam-roller has passed one morning since without affecting the whatnot or the watch."

A TELEGRAM from Calcutta of date October 22 states that Mr. Graham and his Swiss guides returned to Darjeeling on the previous evening. He pronounces the ascent of Kinchinjunga rom the south impracticable; but he has succeeded in ascending another mountain 24,000 feet high.

THE *Sanitary Engineer*, which has for some time been published in New York, is now to be published simultaneously in England and America.

DR. KING'S annual report on the Government Cinchona Plantations in Bengal for the year 1882-83, which is dated May 11 last, is a review of the work in the plantations down to March 31. The planting operations of the year show a grand total of cinchona trees on the Government estate at the last-mentioned date of 4,711,168 of all sorts; this is a decrease, we are told, of about 50,000 on the returns of the previous year, the falling-off being due to the uprootal of 20,000 hybrids, and 43,697 *Calisayas*, which were shown on analysis to have bark of rather poor quality. Dr. King says: "The removal of these inferior trees is in conformity with the policy which has been followed for some years of raising the standard of the produce of these estates by cultivating only the finest kinds of quinine yielders. In conformity with the same policy 160,085 red bark trees, which had to be uprooted in the ordinary rotation followed on the plantation, were replaced, not by red barks, but by yellow barks and hybrids. Ground was, towards the end of the year, broken at Runjung, in the new cinchona reserve across the Tiesta. A European assistant has been located there, and preliminary measures have been taken for planting out there, during the year now entered upon, a number of the best kinds of *Ledgeriana* and hybrid cinchonas." Regarding the crop of bark harvested during the year, Dr. King says it was the largest ever obtained from the plantations, and amounted to 396,980 lbs. of dry bark, 38,880 lbs. of which were collected on the young plantation at Sittong, and the remainder on the old plantation. The total crop was divided as follows: 372,610 lbs. of *Succirubra*, 22,120 lbs. of *Calisaya* and *Ledgeriana*, and 2250 lbs. of hybrid bark. The bulk of the crop was made over to the factory for conversion into cinchona febrifuge, 41,800 lbs. being sent home by order of the Secretary of State to be converted, it is understood, into various forms of cinchona febrifuge in this country for trial by the medical department. It seems that the plants yielding Carthagena bark have not thriven, only three plants being alive at the end of the year, and this notwithstanding every care that could possibly be given to them. The quinologist's report for the same period as the preceding is appended to it, and it shows that the net result of the manufacture of febrifuge for the year was 10,363¼ lbs. of ordinary and 300 lbs. of crystalline febrifuge, the cost price of which was lower than in any previous year. It appears that the year's working resulted in a profit of Rs. 66,284.9.5, which, it is stated, is equal to a dividend of 6½ per cent. on the capital, and may be considered satisfactory. On this point Dr. King says: "The quantity of febrifuge supplied to Government departments during the year was 4180½ lbs., and the cost was Rs. 68,988.8, an equal quantity of quinine at Rs. 96 per lb. would have cost Rs. 4,01,328. The saving to the State effected by substituting febrifuge of Government manufacture for English-made quinine was therefore Rs. 3,32,340."

MR. CHARLES F. PARKER, the curator in charge of the Academy of Natural Sciences of Philadelphia, died September 7, after an illness of several months. Mr. Parker had paid special attention to the botany of New Jersey, and, both in the completeness of his herbarium and the accuracy of his knowledge of it, he had few, if any, equals.

MR. F. E. SAWYER sends us reports of two papers in which he gives the results of his investigations on the folk-lore and superstitions of Sussex. There is also a paper by him in Part vii. of the *Folk-lore Journal* on St. Swithin and the rain water. The same number contains part 6 of Mr. Sibree's valuable collections on "The Oratory, Songs, Legends, and Folk-tales of the Malagasy."

AT the Upsala University a young lady, only seventeen years of age, has just taken the first degree of examination.

THE additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus sinicus* ♂ ♀) from India, presented by Mr. John Verinder; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. W. H. B. Morris; a Bonnet Monkey (*Macacus sinicus*) from India, presented by Miss Stokes; a Geoffroy's Cat (*Felis geoffroii*), a Chilian Sea Eagle (*Geranoætus melanoleucus*) from Uruguay, presented by Mr. Charles S. Barnes; a Crested Porcupine (*Hystrix cristata*) from Africa, presented by the Earl de Grey; a Purple Gallinule (*Porphyrio cæruleus*), European, presented by Mr. Robert Dowling; a Golden-headed Conure (*Conurus auricapillus*) from South America, presented by Mrs. Robins; a Smooth Snake (*Coronella lævis*), British, presented by Mr. W. H. Pain; an Æsculapian Snake (*Coluber æsculapii*), European, two Redshanks (*Totanus calidris*), British, a Yellow Baboon (*Cynocephalus babouin*), a Gambian Pouched Rat (*Cricetomys gambianus*), a Slaty Egret (*Ardea gularis*) from West Africa, a Little Egret (*Ardea garzetta*), European, a Very Black Lemur (*Lemur nigerrimus* ♂) from Madagascar, purchased; a Brown Bear (*Ursus arctos*), North European, a Puma (*Felis concolor*) from America, a Patas Monkey (*Cercopithecus patas*) from West Africa, two Black-footed Penguins (*Spheniscus demersus*) from South Africa, a Cocteau's Skink (*Macrocincus cocteauii*) from the Cape Verde Islands, deposited.

OUR ASTRONOMICAL COLUMN

PONS' COMET.—Several observers have drawn attention to a remarkable fluctuation in the brightness of this comet in September. M. Bigourdan of the Paris Observatory says that on the 5th of that month it appeared as a faint nebulosity about equal in brightness to a star of the twelfth magnitude, and nearly round. On the 9th, with a power of 500, there was a small nucleus, ill defined but sufficiently distinct from the surrounding nebulosity; the comet's light had increased since the 5th. Moonlight and clouds interfered with observation till the 23rd, when the brightness was much increased, and in a small telescope was equal to that of a star of the eighth magnitude. On the following night, in a fine sky, the comet's aspect was still the same, and its diameter was nearly 2′. On the 27th a considerable change had taken place; the nebulosity was much fainter, and the nucleus distinct from it was from 10–11m. After that date the nucleus further diminished, and on October 6 was only of 12m., though the comet as a whole was more easily seen than at the beginning of September. Thus on September 24 the comet was of 8m., while its brightness, calculated from that of September 5, would have assigned it only 11–12m. It therefore had, as M. Bigourdan remarks, for some time a brightness thirty to forty times that given by theory, which, he says, it is difficult to reconcile with the opinion that comets have not a light of their own.

Herr Rumker, observing at Hamburg, noticed similar variation. On September 23 he had seen the comet as "ein sehr helles Object mit einer glanzenden Verdichtung." On September 27 and following nights, "glich der Comet einem sehr blassen, unregelmässigen, ziemlich grossen Nebel mit einem Kleinen kaum sichtbaren condensations-centrum." The contrast, he says, was so striking that on September 27 he at first doubted if he had the comet in the field.

Baron von Engelhardt found the comet fainter on October 1 than on September 28, but on the latter night it was much better seen with a 5-inch comet-seeker than with a power of 140 on the equatoreal.

THE GREAT COMET OF 1882.—The weather during the last moonless period appears to have been very unfavourable, at least in this country, and there was no opportunity for satisfactory examination of the position of the great comet of 1882, on the chance of glimpsing it with our larger instruments as the earth somewhat overtook it on its course. The theoretical intensity of light during the next period of absence of moonlight is slightly less, but we continue an ephemeris from the elliptic elements calculated by M. Fabritius:—

At Greenwich Midnight

	R.A. h. m. s.	N.P.D. ° ′	Log. distance from Earth.	Sun.
Oct. 27	7 31 37	103 58·6	0·7637	0·7767
28	– 31 22	104 3·9		
29	– 31 6	— 9·1	0·7630	0·7782
30	– 30 50	— 14·3		
31	– 30 32	— 19·5	0·7624	0·7796
Nov. 1	– 30 14	— 24·6		
2	– 29 55	— 29·7	0·7618	0·7810
3	– 29 36	— 34·7		
4	– 29 16	— 39·7	0·7612	0·7824
5	– 28 55	— 44·6		
6	– 28 34	— 49·5	0·7606	0·7838
7	– 28 12	— 54·3		
8	7 27 48	104 59·0	0·7600	0·7851

THE VARIABLE STAR U CEPHEI.—A minimum of this variable was observed by Mr. Knott at Cuckfield, on the evening of October 20. The time was 8h. 34m. G.M.T., and the star's magnitude was 9·2. The minimum fell an hour later than Schmidt's elements (*A. N.* 2382) would predict. The divergence of Mr. Knott's observations has increased to that amount from nine minutes in 1881; at the same time he doubts if a slight increase of the adopted period would of itself completely satisfy the observations, and perhaps the period may be subject to variation.

Reckoning from the minimum on October 20, and using Schmidt's mean period, the next few minima will fall thus:—

October 30, 7h. 52m. G.M.T. ... November 9, 7h. 11m.
November 4, 7h. 31m. G.M.T. ... November 14, 6h. 50m.

PHYSICAL NOTES

AT the British Association meeting a paper by Prof. J. A. Ewing was read, on the magnetic susceptibility and retentiveness of iron and steel. This paper was a preliminary notice of some results of an extended investigation which the author had been conducting for three years in Japan. Experiments with annealed rods and rings of soft iron wire showed that that material possesses the property of retentiveness in a very high degree. As much as 90 and even 93 per cent. of the induced magnetism survived the removal of the magnetising force. The extraordinary spectacle was presented of pieces of soft iron entirely free from magnetic influence nevertheless holding an amount of magnetism (per unit of volume) greatly exceeding what is ever held by permanent magnets of the best tempered steel. The magnetic character of the iron in this condition was, however, highly unstable. The application of a reverse magnetising force quickly caused demagnetisation, and the slightest mechanical disturbance had a similar effect. Gentle tapping removed the residual magnetism completely. Variations of temperature reduced it greatly, and so did any application of stress. On the other hand, the magnetism disappeared only very slowly, if at all, with the mere lapse of time. The residual magnetism in hardened iron and steel was much less than in soft annealed iron. The maximum ratio of intensity of magnetism to magnetising force during the magnetisation of soft iron was generally 200 or 300, and could be raised to the enormous figure of 1590 by tapping the iron while the magnetising force was being gradually applied. A number of absolute measurements were made of the energy expended in carrying iron and steel through cyclic changes of magnetisation; and the effects of stress on magnetic susceptibility and on existing magnetism were examined at great length. The whole subject was much complicated by the presence of the action which, in previous papers, the writer had named *Hysteresis*, the study of which, in reference both to magnetism and to thermoelectric quality, had formed a large part of his work.

M. P. TIHON has lately shown at the Industrial Science Society of Lyons a new semi-incandescent lamp, giving the brilliancy of an arc light. This is attained by having two carbon rods, slightly inclined to one another, brought down on to a small prism of chalk, and separated from one another by a small rod of the same material. The current passes through the chalk rod making it incandescent. By this means the light is rendered steadier than an arc light, and it is said to have the same brilliancy.

MR. FRANK GERALDY has published some interesting statistics comparing the cost of the electric light with gas, both as to its actual cost and its cost per candle power:—

Installation.	Electric light system.	No. of lamps.	Candle power of lamps.	Motor.	Total cost per hour gas.	Total cost per hour electric light.	Cost per candle power gas.	Cost per candle power electric light.
Salle de Télégraphistes at Brussels (Nord)	Jaspar	3	235	Gas	1·86	3·82	0·0265	0·0054
Halle aux marchandises, Lyons Station (Paris) ...	Lontin	18	64	Steam	6·825	6·625	0·0273	0·0054
Spinnery at Riverside (United States)	Brush	71	75	"	36·80	11·68	0·0353	0·0022
Ducommun Establishment at Mulhouse	Serrin	4	110	"	—	6·64	0·044	0·015
Passage in the Friedrich-strasse (Berlin)	Siemens	10	50	Gas	9·14	6·45	0·040	0·013
Thames Embankment... ...	Jablochkoff	20	28	Steam	—	0·487	0·0150	0·018
Spinnery of E. Manchon (Rouen)	Sautter-Lemonnier	6	150	"	9·550	7·387	0·0597	0·0082

This is only an extract from a longer list, but conclusively shows that in large instalments electric lighting is cheaper than gas on the total cost; whilst considered per candle power it is far away cheaper. An exception to the rule seems to occur in the first on the list; this is due to the smallness of the installation. In the case of the Thames Embankment the light is reduced by the use of ground glass globes. If we bear in mind the fact that the economy consists in having large installations, we shall be brought face to face with the fact that whereas gas is now made in as large quantities as is practicable, electricity has still to be brought to that state of economy. Thus we may still expect a greater economical advantage than is shown by the above figures.

M. J. JAMIN has a paper in the *Journal de Physique* on the "Critical Point of Liquefiable Gases," in which he discusses a new theory. He says: "I believe that gases are liquefiable at all temperatures when the pressure is sufficient." Describing Cagniard-Latour's experiment, he says: "According to known laws, the quantity of vapour above the liquid increases very rapidly, its density increasing at the same rate as its weight without known limit. Again, the remaining portion of the liquid expands at an increasing rate until it passes that of the gas (Thilorier); it is clear then, by the effect of these inverse variations, that at last a limiting temperature must be reached when the liquid and the vapour must have the same weight for the same volume. At this point they are inseparable; the vapour does not rise nor the liquid fall, and the surface of the liquid disappears." Thus the critical point is the temperature when a liquid and its saturated vapour have the same density. From the experiments of Cagniard-Latour he deduces that at the critical point a liquid has no latent heat, and in summing up he says: "At the critical point there is no difference between a liquid and its vapour, neither in tension, nor density, nor thermal constitution, nor appearance, nor any property by which they can be distinguished."

PROF. H. S. CARHART, of Evanston, Ill., has made some researches on the effect on the magnetic field of the rotation of a pierced iron disk in front of the poles of a magnet. The result of this research is that he has found that an iron screen with a hole in it held in front of the pole of a magnet acts magnetically, as a screen with a hole in it held near a light acts optically, the shape of the hole being clearly defined; thus showing the difference of intensity of the field when the iron is there and when it is removed. He has made use of this property by placing a small coil capable of inductive action opposite each pole of a horseshoe magnet; in between the coils and the magnet he rotated a disk of iron with two concentric circles of holes a quarter of an inch in diameter, which came exactly opposite the two poles of the magnet. The inner circle contained thirty-two holes, and the outer contained sixty-four. The two induction bobbins he had connected up with a telephone. When the disk was rotated, he distinctly heard two musical notes produced which were an octave apart. The name given to this instrument is the magnetophone.

MR. E. VAN DER VEN has been making some researches on the use of phosphor bronze and silicon bronze wires for lines, the practical results of which are: that their resistances compared with copper of the same diameter are, phosphor bronze, 30 per cent.; silicon bronze, 70 per cent.; steel being 10·5 per cent. The stretch that can be given from pole to pole is, for steel, 2 mm. diameter, 130 feet; phosphor bronze or silicon bronze, 1 mm. diameter, 106 and 91 feet respectively. Another great point is that a bronze wire, on account of its elasticity, would coil up before it had fallen far if broken, thus preventing accidents from broken wires.

THE GREAT TIDAL WAVE

WE have received several communications on extraordinary tidal phenomena, which seem to be connected with the great earthquake disturbance in Java in August last. We bring these communications together here:—

I have received an interesting letter from Major A. W. Baird, R.E., who directs the Tidal Department of the Survey of India, on the results of the earthquake in Java. The extract from the letter, which I append, speaks for itself. It may be worth mentioning, however, that Negapatam in the Carnatic and Port Blair in the Andaman Islands are nearly in the same latitude and on opposite sides of the Bay of Bengal. It is to be hoped that Major Baird will communicate the results of his investigation to some scientific society in this country.

Trin. Coll., Camb., October 18 G. H. DARWIN

INDIA

Extract from a Letter from A. W. Baird to G. H. Darwin, dated Poona, September 27, 1883

"The wave caused by the volcanic eruption at Java is distinctly traceable on all the tidal diagrams hitherto received, and I am informed of great tidal disturbance at Aden on August 27; but the daily reports are always meagre in information. Kurrachee and Bombay also show the disturbance, and as far as I have examined the wave reached half way up to Calcutta on the Hooghly.

"Negapatam was most disturbed, and at Port Blair there was very great disturbance. I have reports from Port Blair of tremendous noises as if a ship was firing guns as signals of distress, and they sent out a steamer to look about. Similar reports come from the Nicobars, and I see by the papers the noises were heard at Tavoy and Mergui in Burmah.

"I am collating the information and getting up diagrams showing the tide-curves of August 27 and 28, all in Port Blair time, and all on the scale $\frac{1}{12}$. I am of opinion that I can distinctly prove the first wave to be negative, and that it certainly extended to Negapatam, thus showing that there must have been at first an enormous depression or subsidence at the bottom of the sea in the Straits of Sunda.

"By proper handling of the records I hope to deduce the velocity of the wave from Java to Aden, and from Java up the Bay of Bengal. . . . .

"Unfortunately it will take a long time to get the information about the time the wave was generated; but I am leaving no stone unturned to get it. I have sent about twenty circulars to various port officers, and I have asked —— to ask for information from Batavia."

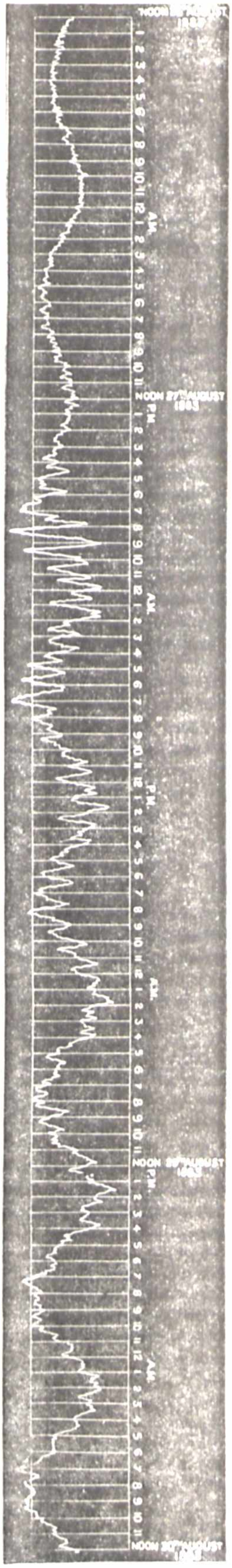
SOUTH AFRICA

Some tidal stations have recently been established, on my recommendation, along the coast of South Africa, and the results obtained from the observations will be ultimately discussed. Meanwhile I inclose herewith a tracing from the tidal diagram at one of these stations (taken at Port Elizabeth under Mr. Shield, harbour engineer), covering the period from noon on August 26 to noon on August 30. It will be seen from the diagram that till 4 p.m. on August 27 the curve was perfectly normal.

At 8 p.m. on August 27 an extraordinary oscillation, having a period of about an hour, commenced, and at 9 p.m. had attained a range of five feet. It then gradually but very slowly subsides.

Mr. Shield thinks, and I agree with him, that the tidal disturbance in question has its origin probably in the recent disturbance in the Straits of Sunda. Our information here is as yet very defective. Accurate data as to that disturbance would be of the greatest interest. DAVID GILL

Royal Observatory, Cape of Good Hope, Sept. 25



The Tidal Wave, South Africa.

MAURITIUS

In the Mauritius *Mercantile Record* of September 8, Mr. C. Meldrum gives a collection of data on the phenomena observed in the neighbourhood of Mauritius. One of the local papers, the *Progrès Colonial*, gave, in its issue of August 29, an account of a curious phenomenon observed in the harbour of Port Louis, by Capt. Ferrat, of the s.s. *Touareg*. The *Touareg* was moored in the Trou Fanfaron, near the Patent Slip. Towards 2 p.m. on August 27 Capt. Ferrat, who was then on board of his vessel, observed that in that part of the harbour the sea suddenly receded, leaving the rocks in the neighbourhood dry. The level of the water, it is said, fell to the extent of four or five feet. About a quarter of an hour after, the sea regained its former level with extreme violence, causing the *Touareg* and other vessels to roll frightfully. An alternate lowering and rising of the sea-level continued till 6 p.m. By 7 p.m. all had disappeared. On the morning of the 28th, however, there were still strong currents. In its issue of August 31, the same paper reports that, while traversing the pass between Round Island and the Coin de Mire, on the 27th, a Government boat, though running before a strong breeze, was stopped by a current from the opposite direction, and that the *patron* observed the sea receding precipitately from the vicinity of Gabriel Island, leaving the reefs dry, but that in a few minutes they were, by a sudden reflux, covered with water to the depth of six feet. The *Mercantile Record* of August 30 reported that on the 27th the sea in the Trou Fanfaron went down every twelve minutes, leaving all the boats moored in front of the harbour workshed dry, and then immediately rose again. The *Touareg* and *Stella* seemed to be in a boiling sea. On the 27th the sea in Tombeau Bay suddenly fell five feet below its usual level, and fish were caught on the dry beach. A quarter of an hour later the sea returned and rose nearly five feet above its ordinary level. Similar phenomena were observed at the Morne Brabant. On the same day, remarkable atmospheric and magnetic disturbances were recorded at the Royal Alfred Observatory, Pamplemousses. It would thus appear that from at least Flat Island, about eight miles north of the mainland of Mauritius, to Port Louis on the west coast, and thence round by the Morne to Souillac on the south coast, a distance in all of about forty-six miles, an unusual perturbation occurred with regard to the level and motion of the sea-water, and that on the same day meteorological and magnetic perturbations were recorded at the Observatory. The interest created by these occurrences was heightened by the report that vessels which arrived from the eastward on August 28 had passed through fields of pumice-stone.

Mr. Meldrum then gives a short account of what happened at the Observatory, and relates what has been told him by eye-witnesses of what occurred in the harbour and elsewhere.

1. *Barograms.*—The barogram sheet for the forty-eight hours ending at 8 a.m. on the 28th shows a remarkable disturbance in the atmospheric pressure between 11 a.m. and 5 p.m. on the 27th. Under ordinary conditions the barometer invariably falls from a maximum at about 9.30 a.m. to a minimum at about 3.30 p.m. But on August 27 last this was not the case. Soon after 11 a.m. a slight disturbance began, as indicated by small successive indentations in the barogram. At 11.55 a.m. the mercury stood at 29·996 inches, and at 0.06 p.m. at 29·918; it then rose to 29·961 at 0.20 p.m., after which it fell to 29·916 at 1.10 p.m. From 1.10 to 3.00 p.m. it rose, and at the latter hour stood at 29·968. In the interval from 2.50 to 3.55 p.m. there were five wavelets, and the mean interval between their lowest points was 16 minutes. Upon the whole, however, the mercury continued to rise after 1.10 p.m. The sudden fall from 11.55 a.m. to 0.06 p.m., and the rise from 0.06 to 0.20 p.m., are shown by a projecting peak. This peak, the undulations from 2.50 to 3.55 p.m., and the fact that the minimum occurred fully two hours earlier than usual, are the principal characteristics of the disturbance. After 5 p.m. there was no trace of disturbance.

A smaller disturbance occurred between 9 p.m. and midnight on the 28th.

2. *Magnetograms.*—Towards 9 a.m. on the 27th the north end of the declination magnet began to move towards the west, at first slowly and then more rapidly, and at 11 a.m. it attained its westerly maximum position, the movement since 9 a.m. amounting to 7′ 37″ of arc. An easterly movement then set in, and continued till 0h. 15m. p.m., the north end being then 13′ 18″ east of its position at 11 a.m. A slight westerly movement of 3′ 18″ then occurred up to 1h. 20m., after which there was a rapid movement towards the east till 2 p.m., the decrease in declination since 1h. 20m. being 10′ 37″. The magnet then moved towards the west, recovering its normal position about 5 p.m., and all traces of disturbance ceased. From 10 to 11 a.m., and especially from 11 a.m. to 1 p.m., there were several minor oscillations. The extreme range from the maximum westerly position at 11 a.m. to the maximum easterly position at 2 p.m. was 20′ 43″.

The dip, or vertical force magnetometer, as indicated by the curve, shows traces of disturbance between 8h. 15m. and 11h. a.m. on the 27th. At the latter hour a rapid decrease of force began and continued till 0h. 15m. p.m., the decrease amounting in parts of force to ·00086, and the south end of the magnet moving upward through an angle of 16′ 07″. From 0h. 15m. to 1h. 20m. a slight increase of force took place, amounting to ·00027, the south end of the magnet dipping to the extent of 5′ 06″. After 1h. 20m. a very rapid decrease set in, which continued till 1.50 p.m., the decrease amounting to ·00083, and the south end of the magnet moving upward through an angle of 15′ 38″. The force then gradually increased and recovered its normal value at 6 p.m., by which time it had increased to the extent of ·00104 parts of force since 1h. 50m., the south end of the magnet moving downward through an angle of 19′ 36″. The total decrease from 11 a.m. to 1h. 50m. p.m. was ·00142, during which interval the range of angular movement was 26′ 40″. There were several minor oscillations, particularly between 11 a.m. and 0h. 40m. p.m.

The horizontal force curve also shows a well-marked disturbance, but it was less than in the case of the other curves.

The principal features of these disturbances were the unusually large ranges of the movements of the magnets, and the differences between the epochs of maximum and minimum and the average epochs.

Magnetic disturbances occurred also on August 28 and 29.

Disturbances in the Trou Fanfaron.—Capt. Ferrat states that at some time between 1.30 and 2 p.m. on the 27th the water rushed inwards from the harbour with great violence, and rose above its former level to the extent of fully three feet. An alternate ebb and flow then continued till nearly 7 p.m., the intervals in time between low and high water being about 15 minutes. There was no wave or billow, but a strong current, the estimated velocity of which was about three knots in ten minutes, or eighteen knots an hour. The current appeared to be strongest towards evening. Similar disturbances, but less marked, were observed on the morning of the 28th.

On the opposite side of the Trou Fanfaron another observer noticed, about 2 p.m. on the 27th, that around the *Stella*, which was moored within about 25 yards of him, the water had a "boiling appearance." The water then receded about 20 feet from the shore, leaving some boats near him partly on dry land. About a quarter of an hour after the water rushed back and advanced about six feet farther inland than where it was at 2 p.m. The water then receded, and a series of oscillations took place till about 6 p.m., the intervals between high and low water being from 15 to 20 minutes, and the extent of rise and fall which was at first about three feet, becoming less and less after 4 p.m.

These statements accord with others previously made to the Hon. Mr. Connal.

Similar phenomena, but of a less violent character, occurred between 2.30 and 6 p.m. on the 28th.

The Trou Fanfaron, it may be remarked, is a narrow inlet on the north-east side of the harbour. Near its mouth, or entrance, its direction is south-west and north-east; it then turns towards the east, and throughout the greater part of its length (about 1600 feet) it runs nearly east and west. Its breadth is generally from 200 to 300 feet.

Similar disturbances were observed at Arsenal and Tombeau Bays.

On August 11 and 12 the *Idomene*, in 6° to 8° S., and in 88° E., passed through fields of pumice-stone, which may have been ejected from a volcano near the Straits of Sunda. At all events, that pumice-stone had no immediate connection with what took place in Mauritius.

"I will at present," Mr. Meldrum concludes, "make no attempt to explain the phenomena in question. Magnetic disturbances, properly so-called, are not produced by earthquakes, but are generally ascribed, in a measure at least, to cosmical causes. The disturbances of the magnets on this occasion, however, may have been mechanical effects of earth-waves, although no permanent change of level took place. The difficulty is to refer all the phenomena to the same cause."

THE MOTION OF WATER[1]

1. *Objects and Results of the Investigation.*

THE results of this investigation have both a practical and a philosophical aspect.

[1] "An Experimental Investigation of the Circumstances which Determine whether the Motion of Water shall be Direct or Sinuous, and of the Law of Resistance in Parallel Channels." Abstract of Paper read at the Royal Society by Prof. Osborne Reynolds, F.R.S.

In their practical aspect they relate to the *law of resistance to the motion of water in pipes*, which appears in a new form, the law for all velocities and all diameters being represented by an equation of two terms.

In their philosophical aspect these results relate to the fundamental principles of fluid motion; inasmuch as they afford for the case of pipes a definite verification of two principles, which are *that the general character of the motion of fluids in contact with solid surfaces depends on the relation* (1) *between the dimensions of the space occupied by the fluid and a linear physical constant of the fluid;* (2) *between the velocity and a physical velocity constant of the fluid.*

The results as viewed in their philosophical aspect were the primary object of the investigation.

As regards the practical aspects of the results it is not necessary to say anything by way of introduction; but in order to render the philosophical scope and purpose of the investigation intelligible it is necessary to describe shortly the line of reasoning which determined the order of investigation.

2. *The Leading Features of the Motion of Actual Fluids.*—Although in most ways the exact manner in which water moves is difficult to perceive, and still more difficult to define, as are also the forces attending such motion, certain general features both of the forces and motions stand prominently forth as if to invite or defy theoretical treatment.

The relations between the resistance encountered by, and the velocity of a solid body moving steadily through, a fluid in which it is completely immersed, or of water moving through a tube, present themselves mostly in one or other of two simple forms. The resistance is generally proportional to the square of the velocity, and when this is not the case it takes a simpler form, and is proportional to the velocity.

Again, the internal motion of water assumes one or other of two broadly distinguishable forms—either the elements of the fluid follow one another along lines of motion which lead in the most direct manner to their destination, or they eddy about in sinuous paths, the most indirect possible.

3. *Connection between the Leading Features of Fluid Motion.*—These leading features of fluid motion are well known, and are supposed to be more or less connected, but it does not appear that hitherto any very determined efforts have been made to trace a definite connection between them, or to trace the characteristics of the circumstances under which they are usually presented.

Certain circumstances have been definitely associated with the particular laws of force. Resistance as the square of the velocity is associated with motion in tubes of more than capillary dimensions, and with the motion of the bodies through the water at more than insensibly small velocities, while resistance as the velocity is associated with capillary tubes and small velocities.

The equations of hydrodynamics, although they are applicable to *direct motion, i.e.* without eddies, and show that then the resistance is as the velocity, have hitherto thrown no light on the circumstances on which such motion depends. And although of late years these equations have been applied to the theory of the eddy, they have not been in the least applied to the motion of water, which is a mass of eddies, *i.e.* in *sinuous motion*, nor have they yielded a clue to the cause of resistance varying as the square of the velocity. Thus, while as applied to waves and the motion of water in capillary tubes the theoretical results agree with the experimental, the theory of hydrodynamics has so far failed to afford the slightest hint why it should explain these phenomena, and signally failed to explain the law of resistance encountered by large bodies moving at sensibly high velocities through water, or that of water in sensibly large pipes.

This accidental fitness of the theory to explain certain of the phenomena, while entirely failing to explain others, affords strong presumption that there are some fundamental principles of fluid motion of which due account has not been taken in the theory; and several years ago it seemed to me that a careful examination as to the connection between these four leading features, together with the circumstances on which they severally depend, was the most likely means of finding the clue to the principles overlooked.

4. *Space and Velocity.*—The definite association of resistance as the square of the velocity with sensibly large tubes and high velocities, and of resistance as the velocity with capillary tubes and slow velocities, seemed to be evidence of the very general and important influence of some properties of fluids not recognised in the theory of hydrodynamics.

As there is no such thing as absolute space or absolute time recognised in mechanical philosophy, to suppose that the character of motion of fluids in any way depended on absolute size or absolute velocity would be to suppose such motion outside the pale of the laws of motion. If, then, fluids, in their motions, are subject to these laws, what appears to be the dependence of the character of the motion on the absolute size of the tube and on the absolute velocity of the immersed body must in reality be a dependence on the size of the tube as compared with the size of some other object, and on the velocity of the body as compared with some other velocity. What is the standard object and what the standard velocity which come into comparison with the size of the tube and the velocity of an immersed body are questions to which the answers were not obvious. Answers, however, were found in the discovery of a circumstance on which sinuous motion depends.

5. *The Effect of Viscosity on the Character of Fluid Motion.*—The small evidence which clear water shows as to the existence of internal eddies, not less than the difficulty of estimating the viscous nature of the fluid, appears to have hitherto obscured the very important circumstance that *the more viscous a fluid is the less prone is it to eddying or sinuous motion.* To express this definitely, if μ is the viscosity and ρ the density of the fluid, for water $\frac{\mu}{\rho}$ diminishes rapidly as the temperature rises; thus at 5° C. $\frac{\mu}{\rho}$ is double what it is at 45° C. What I observed was that the tendency of water to eddy becomes much greater as the temperature rises.

Hence, connecting the change in the law of resistance with the birth and development of eddies, this discovery limited further search for the standard distance and standard velocity to the physical properties of the fluid.

To follow the line of this search would be to enter upon a molecular theory of liquids, and this is beyond my present purpose. It is sufficient here to notice the well-known fact that $\frac{\mu}{\rho}$ is a quantity of the nature of a product of a distance and a velocity.

6. *Evidence from the Equations of Motion.*—In this article it is pointed out that the equations of motion afford definite evidence of a dependence of the dynamical equilibrium of a fluid on the value of $\frac{c\rho U}{\mu}$, c being the diameter of the pipe and U the mean velocity of the fluid.

7. *The Cause of Eddies.*—There appeared to be two possible causes for the change of direct motion into sinuous. These are best discussed in the language of hydrodynamics; but as the results of this investigation relate to both these causes, which, although the distinction is subtile, are fundamentally distinct and lead to distinct results, it is necessary that they should be indicated.

The general cause of the change from steady to eddying motion was, in 1843, pointed out by Prof. Stokes as being that, under certain circumstances, the steady motion becomes unstable, so that an indefinitely small disturbance may lead to a change to sinuous motion. Both the causes above referred to are of this kind, and yet they are distinct; the distinction lying in the part taken in the instability by viscosity. If we imagine a fluid free from viscosity and absolutely free to glide over solid surfaces, then comparing such a fluid with a viscous fluid in exactly the same motion—

(1.) The frictionless fluid might be unstable and the viscous stable. Under these circumstances the cause of eddies is the instability as a perfect fluid, the effect of viscosity being in the direction of stability.

(2.) The frictionless fluid might be stable, and the viscous fluid unstable; under which circumstances the cause of instability would be the viscosity.

It was clear to me that the conclusion I had drawn from the equations of motion immediately related only to the first cause. Nor could I then perceive any possible way in which instability could result from viscosity. All the same I felt a certain amount of uncertainty in assuming the first cause of instability to be general. This uncertainty was the result of various considerations, but particularly from my having observed that eddies apparently come on in very different ways, according to a very definite circumstance of motion, which may be illustrated.

When in a channel the water is all moving in the same direction, the velocity being greatest in the middle, and diminishing to zero at the sid , as indicated by the curve in Fig. 1, eddies showed themselves reluctantly and irregularly; whereas when the water on one side of the channel was moving in the opposite direction to that on the other, as shown by the curve in Fig. 2, eddies appeared in the middle regularly and readily.

8. *Methods of Investigation.*—There appeared to be two ways of proceeding, the one theoretical, the other practical.

The theoretical method involved the integration of equations for unsteady motion in a way that had not then been accomplished, and which, considering the general intractability of the equations, was not promising.

The practical method was to test the relation between U, $\frac{\mu}{\rho}$, and c; this, owing to the simple and definite form of the law, seemed to offer, at all events in the first place, a far more promising field of research.

The law of motion in a straight, smooth tube offered the simplest possible circumstances and the most crucial test.

The existing experimental knowledge of the resistance of

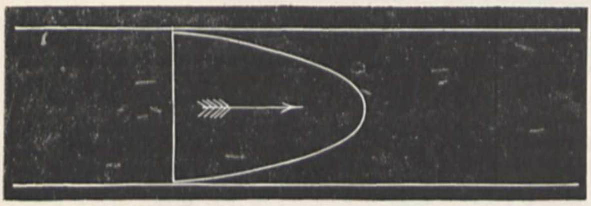


FIG. 1.

water in tubes, although very extensive, was in one important respect incomplete. The previous experiments might be divided into two classes—(1) those made under circumstances in which the law of resistance was as the square of the velocity, and (2) those made under circumstances in which the resistance varied as the velocity. There had not apparently been any attempt made to determine the exact circumstances under which the change of law took place.

Again, although it had been definitely pointed out that eddies would explain the resistance as the square of the velocity, it did not appear that any definite experimental evidence of the existence of eddies in parallel tubes had been obtained, and much less was there any evidence as to whether the birth of eddies was simultaneous with the change in the law of resistance.

These open points may be best expressed in the form of queries to which the answers anticipated were in the affirmative.

(1.) What was the exact relation between the diameters of the pipes and the velocities of the water at which the law of resistance changed: was it at a certain value of c U?

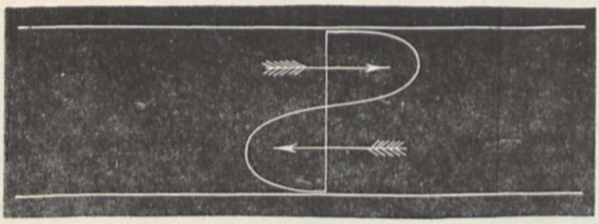


FIG. 2.

(2.) Did this change depend on the temperature, *i.e.* the viscosity of water; was it at a certain value of $\frac{U}{\mu}$?

(3.) Were there eddies in parallel tubes?

(4.) Did steady motion hold up to a critical value and then eddies come in?

(5.) Did the eddies come in at a certain value of $\frac{\rho c U}{\mu}$?

(6.) Did the eddies first make their appearance as small, and then increase gradually with the velocity, or did they come in suddenly?

The bearing of the last query may not be obvious; but, as will appear in the sequel, its importance was such that, in spite of satisfactory answers to all the other queries, a negative answer to this in respect of one particular class of motions led to the reconsideration of the supposed cause of instability, and eventually to the discovery of instability caused by fluid friction.

The queries as they are put suggest two methods of experimenting:—

(1.) Measuring the resistances and velocities for different diameters, and with different temperatures of water.

(2.) Visual observation as to the appearance of eddies during the flow of water along tubes or open channels.

Both these methods have been adopted, but as the question relating to eddies had been the least studied, the second method was the first adopted.

9. *Experiments by Visual Observations.*—The most important of these experiments related to water moving in one direction along glass tubes. Besides these, however, experiments on fluids flowing in opposite directions in the same tube were made; also a third class of experiments which related to motion in a flat channel of indefinite breadth.

These last-mentioned experiments resulted from an incidental observation during some experiments made in 1876 as to the effect of oil to prevent wind waves. As the result of this observation had no small influence in directing the course of this investigation, it may be well to describe it first.

10. *Eddies caused by the Wind beneath the Oiled Surface of Water.*—A few drops of oil on the windward side of a pond during a stiff breeze having spread over the pond and completely calmed the surface as regards waves, the sheet of oil, if it may be so called, was observed to drift before the wind, and it was then particularly noticed that close to, and at a considerable distance from, the windward edge, the surface presented the appearance of *plate glass;* further from the edge the surface presented that wavering appearance which has already been likened to that of sheet glass, which appearance was at the time noted as showing the existence of eddies beneath the surface.

Subsequent observation confirmed this first view. At a sufficient distance from the windward edge of an oil-calmed surface there are always eddies beneath the surface even when the wind is light. But the distance from the edge increases rapidly as the force of the wind diminishes, so that at a limited distance (10 or 20 feet) the eddies will come and go with the wind.

Without oil I was unable to perceive any indication of eddies. At first I thought that the waves might prevent their appearance even if they were there, but by careful observation I convinced myself that they were not there. It is not necessary to discuss these results here, although, as will appear, they have a very important bearing on the cause of instability.

11. *Experiments by Means of Colour Bands in Glass Tubes.*—These were undertaken early in 1880; the final experiments were made on three tubes, Nos. 1, 2, and 3.

The diameters of these were nearly 1 inch, ½ inch, and ¼ inch. They were all about 4 feet 6 inches long, and fitted with trumpet mouthpieces, so that water might enter without disturbance.

The water was drawn through the tubes out of a large glass tank in which the tubes were immersed, arrangements being made so that a streak or streaks of highly-coloured water entered the tubes with the clear water.

The general results were as follows:—

(1.) When the velocities were sufficiently low, the streak of colour extended in a beautiful straight line through the tube (Fig. 3).

(2.) If the water in the tank had not quite settled to rest, at sufficiently low velocities the streak would shift about the tube, but there was no appearance of sinuosity.

(3.) As the velocity was increased by small stages at some point in the tube always at a considerable distance from the trumpet or intake, the colour band would all at once mix up with the surrounding water, and fill the rest of the tube with a mass of coloured water, as in Fig. 4.

Any increase in the velocity caused the point of breakdown to approach the trumpet, but with no velocities that were tried did it reach this.

On viewing the tube by the light of an electric spark, the mass of colours resolved itself into a mass of more or less distinct curls showing eddies, as in Fig. 5.

The experiments thus seemed to settle questions 3 and 4 in the affirmative—the existence of eddies and a critical velocity.

They also settled in the negative question 6 as to the eddies coming in gradually after the critical velocity was reached.

In order to obtain an answer to question 5 as to the law of the critical velocity, the diameters of the tubes were carefully measured, also the temperature of the water and the rate of discharge.

(4.) It was then found that with water at a constant temperature and the tank as still as could by any means be brought about, the critical velocities at which the eddies showed themselves were exactly in the inverse ratios of the diameters of the tubes.

(5.) That in all the tubes the critical velocity diminished as the temperature increased, the range being from 5° C. to 22° C., and the law of this diminution, so far as could be determined, was in accordance with Poiseuille's experiments.

Taking T to express degrees Centigrade, then by Poiseuille's experiments—

$$\frac{\mu}{\rho} \propto P = 1 + 0{\cdot}0336\,T + 0{\cdot}00221\,T^2,$$

Taking a metre as the unit, U_s the critical velocity, and D the diameter of the tube, the law of the critical point is completely expressed by the formula $U_s = \frac{1}{B_s}\frac{P}{D}$, where $B_s = 43{\cdot}7$. This is a complete answer to question 5.

During the experiments many things were noticed which cannot be mentioned here, but two circumstances should be mentioned as emphasising the negative answer to question 6. In the first place, the critical velocity was much higher than had been expected in pipes of such magnitude, resistance varying as the square of the velocity had been found at very much smaller velocities than those at which the eddies appeared when the water in the tank was steady. And in the second place it was observed that the critical velocity was very sensitive to disturbance in the water before entering the tubes, and it was only by the greatest care as to the uniformity of the temperature of the tank and the stillness of the water that consistent results were obtained. This showed that the steady motion was unstable for large disturbances long before the critical velocity was reached, a fact which agreed with the full blown manner in which the eddies appeared.

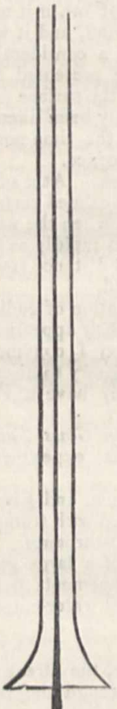


FIG. 3.

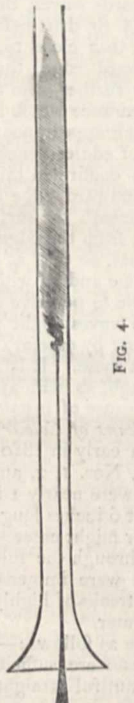


FIG. 4.

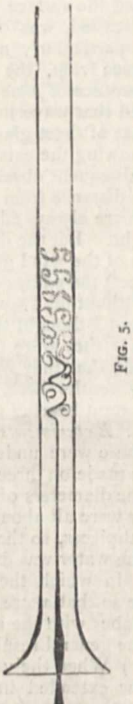


FIG. 5.

12. *Experiments with Two Streams in Opposite Directions in the Same Tube.*—A glass tube 5 feet long and 1·2 inch in diameter, having its ends slightly bent up, as shown in Fig. 6, was half filled with bisulphide of carbon, and then filled up with water and both ends corked. The bisulphide was chosen as being a limpid liquid, but little heavier than water and completely insoluble, the surface between the two liquids being clearly distinguishable. When the tube was placed in a horizontal direction, the weight of the bisulphide caused it to spread along the lower half of the tube, and the surface of separation of the two liquids extended along the axis of the tube.

On one end of the tube being slightly raised, the water would flow to the upper end, and the bisulphide fall to the lower, causing opposite currents along the upper and lower halves of the tube, while in the middle of the tube the level of the surface of separation remained unaltered.

The particular purpose of this investigation was to ascertain whether there was a critical velocity at which waves or sinuosities would show themselves in the surface of separation. It proved a very pretty experiment and completely answered its purpose.

When one end was raised quickly by a definite amount, the opposite velocities of the two liquids, which were greatest in the middle of the tube, attained a certain maximum value depending on the inclination given to the tube. When this was small no signs of eddies or sinuosities showed themselves, but at a certain definite inclination waves (nearly stationary) showed themselves, presenting all the appearance of wind waves.

These waves first made their appearance as very small waves of equal lengths, the length being comparable to the diameter of the tube.

When by increasing the rise the velocities of flow were increased, the waves kept the same length but became higher, and when the rise was sufficient the waves would curl and break, the one fluid winding itself into the other in regular eddies.

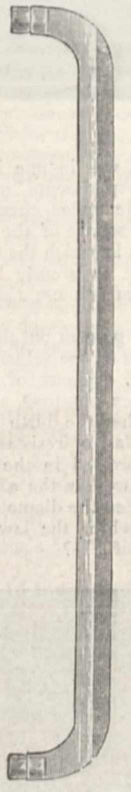


FIG. 6.

FIG. 7.

Whatever might be the cause, a skin formed slowly between the bisulphide and the water, and this skin produced similar effects to that of oil on water; the results mentioned are those which were obtained before the skin showed itself. When the skin first came on, regular waves ceased to form, and in their place the surface was disturbed as if by irregular eddies above and below, just as in the case of the oiled surface of water.

The experiment was not adapted to afford a definite measure of the velocities at which the various phenomena occurred, but it was obvious that the critical velocity at which the waves first appeared was many times smaller than the critical velocity in a tube of the same size when the motion was in one direction only. It was also clear that the critical velocity was nearly if not quite independent of any existing disturbance in the liquids. So that this experiment shows—

(1.) That there is a critical velocity, in the case of opposite flow, at which direct motion becomes unstable.

(2.) That the instability came on gradually and did not depend on the magnitude of the disturbances, or, in other words, that for this class of motion question 6 must be answered in the affirmative.

It thus appeared that there was some difference in the cause of instability in the two motions.

13. *Further Study of the Equations of Motion.*—Here the author explains that he had so far succeeded in integrating the equations of motion as to find that there must be two critical values of the velocity—the one that at which steady motion would break down into eddying motion, the other that at which, as the velocity diminished, previously existing eddies would die out; both these velocities depending on the relation $U \propto \frac{\mu}{\rho c}$.

14. *Results of Experiments on the Law of Resistance in Tubes.*—The existence of the critical velocity described in the previous article could only be tested by allowing water in a high state of disturbance to enter a tube, and after flowing a sufficient distance for the eddies to die out, if they were going to die out, to test the motion. As it seemed impossible to apply the method of colour bands, the test applied was that of the law of resistance as indicated in questions (1) and (2) in § 8. The result was very happy. Two straight lead pipes, No. 4 and No. 5, each 16 feet long, and having diameters of a quarter and half inch respectively, were used.

The water was allowed to flow through rather more than 10 feet before coming to the first gauge-hole, the second gauge-hole being 5 feet further along the pipe.

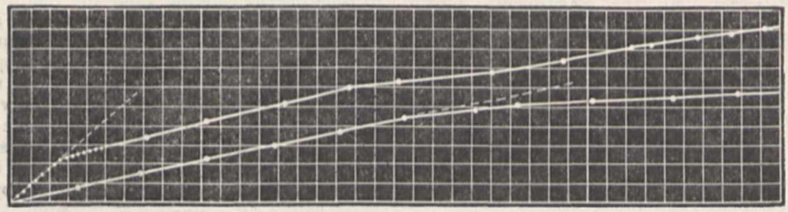


Fig. 8.

The results were very definite, and are partly shown in Fig. 8.

(1.) At the lower velocities the pressure was proportional to the velocity, and the velocities at which a deviation from this law first occurred were in the exact inverse ratio of the diameters of the pipes.

(2.) Up to these critical velocities the discharges from the pipes agreed exactly with those given by Poiseuille's formula for capillary tubes.

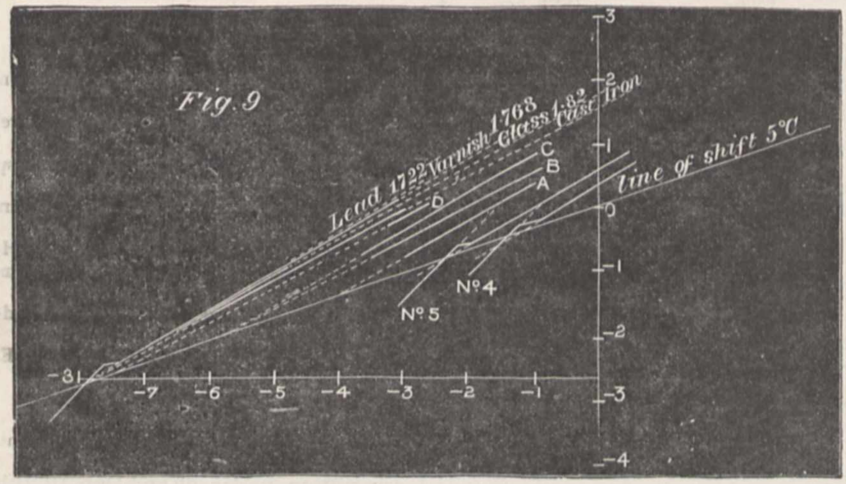
(3.) For some little distance after passing the critical velocity no very simple relations appeared to hold between the pressures and velocities; but by the time the velocity reached 1·3 (critical velocity) the relation became again simple. The pressure did not vary as the square of the velocity, but as 1·722 power of the velocity; this law held in both tubes, and through velocities ranging from 1 to 50, where it showed no signs of breaking down.

(4.) The most striking result was that not only at the critical velocity but throughout the entire motion the laws of resistance exactly corresponded for velocities in the ratio of $\frac{\mu}{\rho c}$. This last result was brought out in the most striking manner on reducing the results by the graphic method of logarithmic homologues as described in my paper on thermal transpiration.

Calling the resistance per unit of length as measured in the weight of cubic units of water i, and the velocity v, $\log i$ is taken for abscissa, and $\log v$ for ordinate, and the curve plotted.

In this way the experimental results for each tube are represented as a curve; these curves, which are shown as far as the small scale will admit in Fig. 9, present exactly the same shape, and only differ in position.

Either of the curves may be brought into exact coincidence with the other by a rectangular shift, and the horizontal shifts are



Pipe No. 4, Lead ... ... 0·00615 m. diameter
" " 5, " ... ... 0·0127 "
" A, Glass ... ... 0·0496 "
Pipe B, Cast Iron ... ... 0·188 m. diameter
" D, " ... ... 0·5 "
" C, Varnish ... ... 0·196 "

given by the difference of the logarithm of $\frac{D^3}{\mu^2}$ for the two tubes, the vertical shifts by the difference of the logarithm of $\frac{D}{\mu}$.

The temperatures at which the experiments had been made were nearly the same, but not quite, so that the effect of the variations of μ showed themselves.

15. *Comparison with Darcy's Experiments.*—The definiteness of these results, their agreement with Poiseuille's law, and the new form which they more than indicated for the law of resistance above the critical velocity, led me to compare them with the well-known experiments of Darcy on pipes ranging from 0·014 to 0·5 metre. Taking no notice of the empirical laws by which Darcy had endeavoured to represent his results, I had the logarithmic homologues plotted from his published experiments. If my law was general, then these log. curves, together with mine, should all shift into coincidence if each were shifted horizontally through $\frac{D^3}{P^2}$, and vertically through $\frac{D}{P}$.

In calculating these shifts there were some doubtful points.

Darcy's pipes were not uniform between the gauge points, the sections varying as much as 20 per cent., and the temperature was only casually given. These matters rendered a close agreement unlikely; it was rather a question of seeing if there was any systematic disagreement. When the curves came to be shifted, the agreement was remarkable; in only one respect was there any systematic disagreement, and this only raised another point; it was only in the slopes of the higher portions of the curves. In both my tubes the slopes were as 1·722 to 1; in Darcy's they varied according to the nature of the material, from the lead pipes, which were the same as mine, to 1·92 to 1 with the cast iron. This seems to show that the nature of the surface of the pipe has an effect on the law of resistance above the critical velocity.

16. *The Critical Velocities.*—All the experiments agreed in giving $v_c = \frac{1}{278} \frac{P}{D}$ as the critical velocity, to which correspond as the critical pressure $i_c = \frac{1}{47700000} \frac{P^2}{D^3}$, the units being metres and degrees Centigrade. It will be observed that this value is much less than the critical velocity at which steady motion broke down.

17. *General Law of Resistance.*—The log. homologues all consist of two straight branches, the lower branch inclined at 45°, and the upper one at n horizontal to 1 vertical, except for the small distance beyond the critical velocity these branches constitute the curves. These two branches meet in a point, O, on the curve at a definite distance below the critical pressure, so that, ignoring the small portion of the curve above the point before it again coincides with the upper branch, the logarithmic homologues give for the law of resistance for all pipes and all velocities $A \frac{D^3}{P^2} i = \left(B \frac{D}{P} v\right)^n$, where n has the value unity as long as either member is below unity, and then takes the value of the slope n to 1 for the particular surface of the pipe.

If the units are metres and degrees Centigrade—

$$A = 67,700,000$$
$$B = 398$$
$$P = 1 + 0·0336\,T + 0·000221\,T^2.$$

This equation then, excluding the region immediately about the critical velocity, gives the law of resistance in Poiseuille's tubes, those of the present investigation, and Darcy's, the range of diameters being from 0·000013 metres (Poiseuille, 1843), to 0·5 metres (Darcy, 1857); and the range of velocities from 0·0026 to 7 metres per sec., 1883.

This algebraical formula shows that the experiments entirely accord with the theoretical conclusions. The empirical constants are A, B, P, and n; the first three relate solely to the dimensional properties of the fluid which enter into the viscosity, and it seems probable that the last relates to the properties of the surface of the pipe.

Much of the success of the experiments is due to the care and skill of Mr. Foster of Owens College, who has constructed the apparatus and assisted me in making the experiments.

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, October 15.—M. Blanchard, president, in the chair.—Note on a formula of Hansen in connection with the mechanism of the heavens, by M. F. Tisserand.—On the measurement of the forces brought into play in the various actions of human locomotion (continued), three illustrations, by M. Marey. By combining the indications obtained from the dynamometer with those yielded by instantaneous photography, a continuous comparison may be made of the forces brought into action with the movements resulting from them. The various applications of these two methods will form the subject of future experiments.—On a memoir by M. Raoult, entitled: "Loi générale de Congélation des Dissolvants,"—report by MM. Cahours, Berthelot, and Debray. Water holding saline bodies in solution freezes at a lower temperature than pure water, and the English physicist Blagden had shown in 1788 that the lowering of the freezing-point due to this cause is in many cases in proportion to the quantity of matter held in solution. This principle is now generalised by M. Raoult, who arrives at the conclusion that the freezing-point of any liquid compounds capable of solidification is lowered by all solid, fluid, or gaseous bodies dissolved in them. The reporters agree with the author that his methods will be found useful in supplying new means for ascertaining by a simple process the degree of purity of given substances.—Trial trip of an electric screw balloon made by MM. A. and G. Tissandier, note by M. G. Tissandier. This preliminary experiment took place at Auteuil on October 8, and was attended by a certain measure of success, although the apparatus proved powerless to prevent the spinning motion of the balloon when heading against aërial currents. The trip will be renewed as soon as certain improvements have been made in the electromotor suggested by this experiment.—Studies made on the summit of the Pic du Midi, with a view to the establishment of a permanent astronomic station, note by MM. Thollon and Trépied.—On the transformation of certain equations of the second degree to two independent variables, and on some integrations thence deducible, by M. R. Liouville.—On a method of isolating the calorific from the luminous and chemical rays, by M. F. van Assche.—On the form and characters of the reflex muscular contraction, by M. H. Beaunis.—On the resisting power of a ring whose outer surface supports a normal pressure, constant as to unity of length of its mean axis, by M. J. Boussinesq.—On surfaces whose total curve is constant, by M. G. Darboux.—Indices of refraction of fluate of lime for the rays of different wave-lengths as far as the extreme ultra-violet, by M. Ed. Sarasin.—Note on a new method of insulating the metallic wires used in telegraphy and telephony, by M. C. Widemann.—Note on the determination of the equivalents of metals by means of their sulphates, by M. H. Baubigny.—On the process at present employed to determine the glucose in cane-sugar, by M. P. Lagrange. The object of this paper is to show that the quantitative analysis of glucose, made on a liquor whether treated or not with subacetate of lead, is liable to serious errors.—Analysis of a specimen of guano from the Cape Verde Islands, by M. A. Andouard.—Zoological dredgings and thermometric soundings in the lakes of Savoy, by M. F. A. Forel.—On the organisation of the *Spadella Marioni*, a new species from the Gulf of Marseilles, by M. P. Gourret.—On some peculiarities in the structure of Tunicata, by M. L. Roule.—Fresh studies on the fossil ruminants of Auvergne, by M. Depéret.—On the treatment of strabismus by means of the capsular "advancement," by M. L. de Wecker.—On the part played by the ligneous vessels in the upward movement of the sap, by M. J. Vesque.—Note on a lunar mirage observed on the night of October 11, by M. Virlet d'Aoust.

CONTENTS

BIBLIOTEKA GŁÓWNA WROCŁAWSKA